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Machinery in Wartime

At the request of the Board of Trade, we draw the attention of all owners and users of machinery to the need to exercise the greatest care to preserve the life of machinery. Foundry machinery is particularly liable to rapid deterioration because of the inevitable presence of abrasive dust and sand. Amongst engineers the foundry industry has a very bad reputation for the manner in which it neglects its plant, and whilst this is true in very many cases, the engineer himself is often to blame for the scant attention he has given to actual working conditions.

A study of the most popular moulding machines will reveal that they are not necessarily the cleverest in design, but the most robust. The stories of manufacturers of moulding machines invariably include one of a broken holiday due to some urgent call to rectify a breakdown, consequent upon prolonged forgetfulness to lubricate the bearings. This problem of neglect by the foundry maintenance staff caused one manufacturer to circularise the users of his machines monthly with a query as to whether regular lubrication had been effected. He found this procedure much cheaper than sending mechanics to rectify totally unnecessary breakdowns.

The breakdown of individual machines, though important of itself, is insignificant compared with the loss of output consequent upon the suspension of a mechanised unit. One of the most troublesome factors in this direction is failure of the hoppers above the moulding machines to deliver sand due to sticking. The temporary measure of a sound clout with a rammer head eventually aggravates the problem. One very experienced foundry manager assures us that the trouble will be entirely eliminated if the hoppers are emptied weekly and thoroughly cleaned. Another possible solution to this problem might be found by prosecuting a research on the protection of moulding boxes—a question which seems to have been neglected up to the moment. This neglect is no doubt due to the fact that originally either cast-iron or wooden boxes were universally used and both were cheap and relatively rust resisting, though cast iron did suffer. Especially was this the case when dry-sand practice was followed.

With the ever-increasing popularity of steel boxes, it seems worth carrying out a series of tests with surface treatments to prolong life, and, though it is admitted that the subject is getting well removed from sand hoppers, reference to the excellent results now being obtained from malleablising boxes may be useful. This, of course, is no longer surface treatment, but a change in the material used, just as Ni-Resist has been used for moulding boxes. A surface treatment for steel and light-weight boxes, which seems worth while experimenting with, is the cementation of the surface with aluminium or a mixture of this metal with chromium oxide.

A method adopted by one foundry possessing a modern mechanised production installation has been to paint all Stauffer as well as other points requiring lubrication a brilliant red. This has been extremely successful, and the lost hours through breakdown have been kept to a minimum, and are materially less than in plants where no such indication has been provided. The Board of Trade state that industry spends £100,000,000 on new machinery per annum, weighing about 1,000,000 tons, "mostly steel." We do not criticise these figures, except we think that "mostly steel" should be corrected to "mostly iron and steel." A statement of major importance appearing in the Board of Trade notice reads: *Firms and men who carefully and regularly attend to the overhaul and proper treatment of machinery and plant are doing a real service. Besides doing their own job, they are also materially helping to release men and metals for further war effort.*

It is to be hoped that, as a result of war conditions, the foundry industry will lose its reputation for poor maintenance work, and because of the severe conditions encountered become a model which other industries will be pleased to emulate.

A Code for Industrial Light Conditioning

That factory lighting is regarded as an essential aid to increased production of war commodities is obvious from the recent Orders of the Ministry of Supply and the Ministry of Labour. This legislation, based on the report of an expert Department Committee, indicates that peacetime methods and standards, and possibly peacetime equipment, are not entirely suitable for the present.

In the last twenty-five years the main development has been directed towards the provision of cheaper foot-candles, and the lighting installation which was deemed to be the most acceptable to the factory executive was the one which provided the desired level of illumination at the lowest cost, often without regard to its suitability. Under present conditions the quality of the lighting is of paramount importance; because artificial lighting is used for some 50 to 100 per cent. of the working hours, it must not only be the means of enabling the worker to see clearly but must also maintain his health and thus preserve his efficiency.

Trend of Peacetime Development

The trend of development has, as already indicated, resulted in the provision of cheaper foot-candles, and installations planned only to achieve a given level of illumination have fallen in cost as compared with the value of the commodities produced by their aid. If one considers the enormous increase in production brought about in the last few months by virtue of a willing extra effort on the part of the operatives and as the result of longer working hours, the cost of a peacetime installation expressed as a percentage of the value of factory output has again fallen until now it assumes insignificant proportions. However, the curve of output cannot be expected to continue at a high level unless the lighting is made suitable to present conditions.

It is thus found that at a time when a more carefully-designed lighting installation is required, the reduction in overhead costs brought about by the very conditions which require the improved lighting also makes it economically possible.

Wartime Suitability

Suitable lighting may be described as lighting which reveals the work in such a way that the natural ability and efficiency of the operative is not restricted by the lighting conditions, that the operative is not conscious of any limitation in the lighting, and that he is not subjected to strain—physical, mental or psychological—due to any effect of the factory lighting conditions as a whole.

In propounding the view that the quality of the lighting is of great importance, the lighting engineer may be confronted by demands for proof, but in seeking for such proof one is led into the realms of psychology and vision, subjects where quantitative data are rare. The removal of strain and the enormous improvement in the condition and performance of the operative brought about by the provision of a high-quality lighting installation will, however, demonstrate the value of the installation in far more convincing terms than the recitation of a long list of cold figures. It is interesting to note that this disposes convincingly of the old belief that eye strain is the result of general physical depression, proving that the reverse is more likely the case.

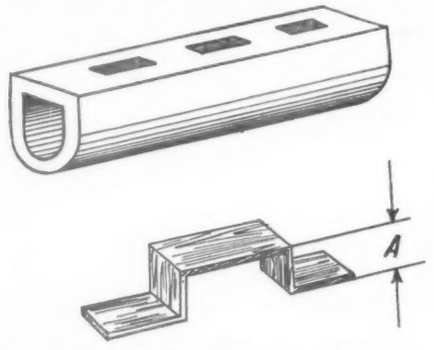
In some recent work done in the Research Laboratories of the B.T.-H. at Rugby, it was felt that the type of high-quality lighting installation more likely to eliminate eye strain and other attendant disabilities was one in which

(*Continued in next column.*)

Some Jobbing Foundry Experiences—XIII

By "TRAMP"

Chaplets and perforated studs are frequently used to support cores during casting, and a supply of them is kept in most shops. Some jobbing foundries, however, often resort to home-made expedients to secure similar results. Fig. 1 shows a casting with outlets at one end and along the top, the far end being closed. As this job is bedded in the floor and cast in the position shown, some support is necessary for the core at the closed end. Being of light section, a perforated stud would be ideal for this



FIGS. 1 AND 2.—CORED CASTING AND DEVICE TO SUPPORT CORE AT CLOSED END.

purpose, but having none in stock other means had to be adopted. Fig. 2 shows the expedient used. A piece of thin sheet iron was bent to the form shown, the amount A being the same as the thickness of the casting. This was placed at the far end of the casting and held the core in position. Of course, a print was provided at the open end. As the top box touched the core at the three points indicated, this secured the core against "lift."

(*Continued from previous column.*)

adequate illumination was provided by low brightness sources carefully disposed relative to the position of individual operators, and that other causes of fatigue and depression might be avoided by giving attention to the control of the level of brightness in the field of view and to colour rendering, natural daylight being the ideal.

It was at once obvious that the Mazda 80-watt tubular fluorescent lamp, with its exceptional characteristics, would be an ideal source to use, especially as the low surface brightness of the lamp appeared to eliminate direct and reflected glare and the natural colour contributed to psychological welfare.

As a result of the investigations it was found possible to draw up a code, which could be used to cover most of the requirements of high-quality lighting. The points of this code are:—

(1) Regard the problem from the workers' point of view rather than that of the casual observer.

(2) Eliminate glitter from the work and glitter and dazzle from the local field of view.

(3) Provide adequate illumination.

(4) Eliminate dazzle or glitter from the general surroundings.

(5) Provide reasonable brightness of walls, ceilings or other surroundings.

(6) Take into account the purely psychological factors by promoting cheerful, comfortable, and safe working conditions.

(7) Employ full engineering and designing skill to keep installation and maintenance costs at lowest level consistent with the best lighting results.

Random Shots

"For those who like colour on the exterior of a house, porcelain enamel fused on steel has a particular appeal," says an American house journal. It should be pointed out, however, that porcelain-enamelled window-boxes full of "sunflowers" are not looked on with favour by the best people. [Marksman should be "reboiled" for putting over this one.—Editor.]

* * *

"South African Engineer and Foundryman" publishes the time-honoured warning to all furnacemen to wear goggles. The horrible results of not so doing are illustrated by a black square with the inscription "What a blind man sees." An up-to-date version of that very necessary warning over here is suggested by the simple notice, "Do you want to walk home in a black-out every night for the rest of your life?"

* * *

An advertiser in a daily newspaper offers for sale part of a bombproof shelter somewhere in London, to accommodate four persons. Its price is £400, leasehold, the lease being of five years' duration! It took one pessimist to build such a shelter, and now the question is whether he will find four more people in London equally pessimistic.

* * *

One often hears someone say to a friend who has just removed to a new district, "What on earth made you go and live in such a god-forsaken hole?" Mr. Sainty (an official of the London and S.E. Area Board), however, could hardly have found a better 'ole. What could be more appropriate than that Mr. Sainty should live in Claytons Priory in a place called Hassocks? It would be too much to expect that he is in business life a merchant in tin chaplets!

* * *

The canning industry has made great strides of recent years, and since the war all sorts of things have been canned for the first time in history. Tinned piston rings, it seems, are now advocated, and these should make a pleasant change from the usual salmon that appears on the Sunday tea-table.

* * *

"It's a fair treat to 'ear the birds twirping as usual when you come out of the shelter of a morning," said Mrs. Malaprop the other day when she arrived at work on an unusually sunny November morning.

* * *

"County Egg Laying Trials" is the heading of a notice recently published by the Surrey Agricultural Committee. Judging from the number of eggs the milkman leaves once in a while, the County hasn't tried very successfully.

* * *

Out of the Mouths of Babes . . . .

A little girl the other day confessed that she always thought that "minority" meant "either yours or mine." No doubt many of the European minorities one has heard so much of in recent years have often wondered to whom they really do belong.

"MARKSMAN."

Machinability of Austenitic Steels

To improve the machinability of steels with up to 1.7 per cent. carbon, which become definitely austenitic on adding 5 to 44 per cent. Ni or 10 to 20 per cent. Mn, the Inland Steel Company, in Brit. Patent 523,251, recommends the addition of 0.03 to 1 per cent. and 0.03 to 0.478 per cent. of lead.

Two Decades of Foundry Practice*

By JOHN ALLAN

There are few phases of foundry work in which progress has not been made and, in reviewing the events of the past twenty years or so, whilst there is no room for complacency, the average foundryman can be excused for feeling a certain amount of satisfaction at the progress in technique that has taken place during that period.

The older and more sentimental members of the industry, however, can be sympathised with in feeling a tinge of regret at the passing of many of the well-established principles of moulding. The old laborious method of hand ramming moulds has been, to a large extent, superseded by the Sandslinger, jolt and squeeze-type machines. Perfectly-finished patterns and better prepared sands have led to the substitution of spray and paint brush for the old method of finishing moulds by means of sleekers.

At present modern methods are deemed impracticable for finishing large moulds, but it seems reasonably safe to predict that the most stubborn of foundry executives will capitulate to the realisation of the tremendous loss of time incurred, just to uphold an obsolete foundry tradition, namely, the polishing of a mould with plumbago after it has been blackwashed. If a good blackwash is used and the mould has not been sand finished in a wet state, sleeking blackwash is unnecessary.

It is suggested that foundrymen should examine a casting upright that has been simply flooded with blackwash before drying. All the metal that is in the casting has passed down this upright, and almost invariably (always provided the surrounding sand has been firmly rammed) the finish on it is superior to that on any other part of the casting where valuable time has been wasted in polishing the mould and admiring the finish.

Lest this argument be deemed insufficient, reference may be made to the Randupson process of cement moulding—probably the most revolutionary innovation in recent years—to illustrate this point. On pattern withdrawal, finishing by the use of tools is impossible. Of course, when the mould has set, any "whiskers" caused by joints on the pattern are rubbed off, but the contours of the mould are untouched and the job is cast as the pattern leaves it. Where these moulds have been painted over with blackwash, the least fault is to be found in the skin on the casting.

It surely is paradoxical that some of the nicest castings produced to-day are the products of foundries where unskilled and semi-skilled labourers, together with a few skilled supervisors, constitute the personnel.

With the introduction of young men who are able to differentiate between sentiment and usefulness, it is not unlikely that the industry may yet see the day when moulds are finished sensibly. But tradition dies hard, and so the change-over will not be complete until the younger generation is trained, or rather becomes accustomed, to modern methods.

It is argued that modern methods are leading to the elimination of the highly-skilled moulder. Whilst this must be admitted, as testified by the number of jobs cast in dry sand which could easily be made and cast in green sand, they are not wholly responsible for this state of affairs, as will be shown later, and the demand for such men in any case is not as high as 20 years ago.

Hundreds of aeroplane engine castings, castings made to probably the closest limits in the industry to-day, are made by the co-operation of machine, semi-skilled machine attendant, perfectly fitting cores (a credit to the pattern-makers) and a skilled man for coring up and closing. The larger of these castings, such as crankcases, cylinder blocks and superchargers, are sprayed with a mixture of french chalk and plumbago, painted over with a soft brush and a similar mixture, and skin dried. The finish on these castings has to be seen to be appreciated, and when it is considered that they have a tolerance of 0.025 in. on the metal thickness, the quantity of scrap is comfortingly low. The class of work undertaken is, of necessity, mass-produced, and it must be admitted that, where the one-man-one-job process is used, the amount of skill required after a few weeks' practice is reduced to the minimum.

All modern innovations seem to have one end in view—speed of production. In this they have succeeded admirably and, as long as there is a demand for castings on the present-day scale, no apprehension need be felt about the future. The doubt, however, persists that the demand might drop, with the result that many foundries which thrive only on large-scale production could not be run economically. So long as a foundry is engaged on full-time production with only a reasonable amount of scrap, the cost of running and maintenance of plant is negligible, considering the many advantages entailed. What happens when, as seems inevitable, the lean time comes? Costs rise and a very serious problem is faced. Is it worth running at a loss, or sending work out while the attached plant lies idle and its value is depreciating? It is impossible to generalise as to what must be done when the problem presents itself. The men in key positions in the industry are capable of handling it when it arises, and for a young man such as the author to voice an opinion would be unwise, in view of the experience necessary to tackle the problem.

Apart from the cost of installation, where the situation warrants, the advantages of machine over man cannot be overstressed. It is beyond the scope of this Paper to discuss the merits and demerits of the various moulding machines procurable to-day, and in any case the makers of these machines see that the foundryman is kept in constant touch with the improvements they make to their products. Machines can only be used economically where a large quantity is required off one pattern, or where a smaller quantity is required off a number of patterns adaptable to one machine. Where a commodity can be mass-produced, as in the motor-vehicle industry, machines must be installed; from the point of view of speed of production, they are indispensable.

Moulds are uniform in all ways when one man is kept on the same job. This can be a decided disadvantage when things go wrong, resulting in perhaps a whole day's work being scrapped, but when things are going well a long run of good castings is practically assured.

The root of much of the trouble where machines for moulding are used is that they are expected to run twenty-four hours a day, seven days a week, only requiring oiling to keep them in trim. Unfortunately this cannot continue for long, as many odd little troubles crop up to harass still further the foundry executive.

One or two of the machines going out of order in a day might seem trivial, but when a job is rammed in three parts, each on a different machine, one machine giving trouble can result in a whole squad standing idle while the trouble is located and remedied. For maximum output, vigilance in the foundry cannot be relaxed even momentarily.

Scientific Control

The increase in scientific control in the foundry has had far-reaching effects. In the testing of sands alone, great strides have been taken. The various methods of testing sands for green and dry strength, moisture content, permeability and their reactions at varying degrees of heat are too well known to call for description here, and in any case many excellent Papers on this subject have been read by qualified men. It will be sufficient to comment on the results obtained.

Even over a few years there has been an increasing superiority of finish on most castings, due almost solely to better-prepared sands. These are the products of the unselfish experiments carried out by the many authorities on the subject. With the increase in the demand for better finish on the exterior of castings, and in view of the growing tendency to ask for certain passageways for vapour to be located correctly in the as-cast state in order to reduce machining costs, the sand experts had, and have, quite a lot of responsibility. The results obtained are ample testimony of how well they are succeeding.

It is probable that, to facilitate speed of production and reduce machining costs even further, higher demands will be made on the men responsible for the sand preparation. So well have they acquitted themselves, however, that the foundryman can view the future in this respect at least with some degree of complacency.

The growth of the use of oil sands in the foundry is a direct result of such demands. Even in the earliest stages of synthetic sands, with their many advantages—ease of handling, high permeability and fewer stiffening irons required—the possibilities seemed unlimited.

The chief disadvantages seemed to be brought about by the belief that all cores would be successfully cast without vents. Whilst it is possible to cast many jobs with cores without vents—which hitherto was impossible—many cores still need venting. Add to this the cost of oil sands, because they are useless after casting, and it is difficult to pick out many more faults.

Even until recently many foundries had difficulty in preparing a sand sufficiently strong to withstand the erosive force of metal and still be easily knocked out. This difficulty is being slowly overcome.

Synthetic sands seem to be directly responsible for one of the great changes in technique—the building up of a mould by means of cores, using the pattern to leave a mould to act solely as a location for the cores. Many intricate castings which at one time necessitated using three- or four-part boxes are made with only a cope and drag, the actual casting being enclosed by the cores.

Of course, this is an expensive method due to the waste of sand incurred, but where large quantities are required off one pattern, castings can be produced quickly and cheaply. When the total time is calculated, probably no great saving is found, but when it is considered that girls make the cores, a semi-skilled machine attendant rams the job on a machine, and a skilled man is required only to core up the mould, the advantages become apparent. Where the method is employed, the patterns are perfect and the cores fit snugly into position, the moulder quickly assembles the cores and the job is done quickly and accurately.

Where only one or two castings are required off a pattern, to build up a job by means of cores is out of the question, and the orthodox method must be employed.

* A Paper read before the Scottish Branch of the Institute of British Foundrymen, Mr. N. A. W. Erskine presiding. The author was awarded the John Surtees Gold Medal for this Paper.

Sand Plants

To-day, sand plants are available suitable for all classes of foundries. In a modern foundry recently visited by the author the following sand mixing and distributing plant is installed. The cast-up boxes are knocked out over a grid on the floor, beneath which a conveyor belt runs, carrying the sand over a magnetic separator to remove all sprigs, through a screen into buckets which convey the sand above floor level, where it is fed to a Simpson mixer, where new sand and water additions are made. The sand is then fed from the mill into buckets which transfer their load to an overhead belt that passes over all moulding machines, to which are led smaller individual belts which can be started at the discretion of the machine attendant.

The large saving of time must be immediately apparent, and it is extremely difficult to pick out an argument against the installation of such a plant where the situation warrants it. An installation of this kind is impracticable in a large marine castings foundry, but foundry engineers have designed plant suitable for this demand. The cast-up boxes are knocked out over a grid; the sand is raised by means of an inclined conveyor belt on to a revolving screen, whence it passes over a magnetic separator into a large bucket that can be raised at will to tip its contents into a pan-mill to be mixed and milled ready for use. The sand is allowed to drop to the floor, to be wheeled away to the required position for use.

Alternatively, where a Sandslinger is used, the sand can be raised by means of elevators on an endless belt into an overhead hopper, under which the Sandslinger is run for refilling. As this plant is made in different sizes suitable for the needs of various foundries, the advantage of uniformly mixed sand often outweighs the cost of installation.

Elimination of Scrap

It is generally accepted that there will always be a certain percentage of castings returned to the furnaceman. This somewhat fatalistic view is apt to blind the foundryman to the harsh fact that much scrap is caused through carelessness on someone's part. The difficulty is to place one's finger on that carelessness, because the human failing of passing on the blame to someone else is hard to eradicate, and this failing is doing more to retard progress than it is pleasant to contemplate. If everyone who handles a job in its progress through the foundry were as vigilant as he should be, it is feasible to contemplate a foundry where scrap would be non-existent.

In the pursuit of the elimination of scrap there is one avenue as yet not fully explored. Is it realised that the point of view of the man on the floor might prove helpful? Just because he is on the level, or slightly below the level, of the job, it is quite possible that he will see things that the manager might possibly miss in view of the fact that he is looking down on the job. Were the man on the floor encouraged to give voice to his opinion, many new points of varying degrees of helpfulness would be brought to light.

Collaboration

It is pleasing to note the increasing collaboration between moulder and patternmaker, but the progress in this direction is very slow. Patterns are still made without much consideration for the foundryman. Less than a year ago in one of Glasgow's most advanced foundries, the author saw a first-class moulder reduce a pattern almost to matchwood in an endeavour to withdraw it from the sand, just because the patternmaker had not the foresight to affix drawing straps to the side of the pattern. The pattern was of a marine turbine gear case, having as part of its design four perpendicular sides. The pattern was made of yellow pine and, in lying in the sand overnight, swelled, leading to the trouble just mentioned. By consulting the foreman moulder, this trouble could have been avoided, together with much unnecessary trouble and expense.

Fortunately, such incidents are becoming increasingly rare; in fact, collaboration is going a step further, and many jobs are planned on the drawing board for the benefit of the foundry. Many things which are sources of delay and annoyance in the foundry are avoided in this manner.

Cores surrounded completely with metal are observed. The designer points out where a screwed plug will do least harm, and the moulder can see instantly if it is easy to take off a vent at that point. Loose pieces are eliminated by blocking out bosses and flanges, and time is saved in the foundry, where a man might lose valuable time finishing parts of the mould from which loose pieces are drawn in. The more loose pieces there are on a pattern the greater the risk of one jamming and causing irreparable damage.

The positions of gates and risers are planned on the drawing board, and can be made on the pattern, thus saving the moulder considerable time digging them out of the sand. If the situation warrants, a special box can be designed to suit the job on the drawing board, and both pattern and box can be in process of being made at the same time. This co-operation must be encouraged as it saves many patterns from being returned to the patternshop for alterations after they have been moulded and found to be unsuccessful.

Education in the Foundry

There are some points that might have an even more far-reaching effect on the industry than any mentioned previously in the Paper, but which the author is reluctant to enumerate as criticism of the executive side of the industry is involved and might not be accepted favourably. As the point of view of the man on the floor is too rarely expressed, however, the author cannot refrain from using this opportunity to deal lightly with these points.

A point in the modernising of the industry calling for admiration is the demand for a higher standard of education from the young man entering the foundry. This is progressive and works very well where a standard of general education is asked, but when it comes to specialised training these young men are at a loss. The trouble is that there are insufficient training facilities for equipping young men to assume executive positions.

There is no school in Scotland where a young man can start a definite course knowing that at the end of it, supposing he gains first-class honours all through, he is fitted for the position of foundry manager. There is, however, one such school in England where, if a man acquits himself well during his attendance, he is practically assured of an executive position.

It is an indication of the lethargy of the men responsible for the education of the young men that such a course has not been instigated in Scotland by now.

There are many intelligent young men in the industry to-day who need only education to bring to the surface their inherent talents. The industry needs these young men and on an increasing scale too, and the sooner this is widely recognised and something done about it the sooner the present managers can be sure that young virile men are ready to take their places when required.

The number of engineers, chemists and patternmakers holding key positions in the industry to-day rather proves this statement. Great credit is due to these men for the way in which they have adapted themselves to their unusual environment, but to a young man anxious to succeed and unable to find suitable courses to help him, this fact offers poor consolation. It is true that there are a few minor courses which apprentices can attend, but even here there are obstacles in his path. For the foundry apprentice these courses are generally evening classes.

So few of the old moulders have had a good education that they tend to sneer at an apprentice who is trying to do his best for himself and his employer. Should one such young man make a mistake in the practical side of his work and be observed by an older journeyman, he is liable to be subjected to some sneering remark regarding his attending a technical college.

With the increased attention being paid to technical education of apprentices, many firms are astonished at the number of apprentices who will attend evening classes for the first season, but who refuse point blank to attend further, even on threat of dismissal. They rarely admit the real reason, which is that they cannot endure the jibes of their fellow workers.

It is true, now that psychological methods of training are being used and the type of man referred to is slowly dying out, that this difficulty should soon be overcome in persuading apprentices to take up a course of study.

One modern practice to be deplored is the shameful neglect of the practical training of apprentices. This, more than the simplification of moulding, is leading to the elimination of the really skilled moulder. Only in foundries which are not run on the premium bonus system do apprentices receive a thorough grounding on the principles of moulding. As these foundries are becoming increasingly few, grave misgivings must be felt regarding the future, for, no matter how much moulding may be simplified, in some classes of work a high degree of skill is required.

In foundries which are conducted on the premium bonus system apprentices are usually given two-part box jobs and allowed to make them as well and quickly as they can. This satisfies all concerned. The boys are pleased because they can earn a better wage making simple castings, the foundry foreman smiles because, after a little practice, the boys need no supervision, and the costing department smiles complacently because the boys are producing, if not as quickly as journeymen, more cheaply.

This short-sightedness is dangerous and, if it is not remedied shortly, there is no indication where it might lead, but it is fairly certain it will not be for the betterment of the trade. The number of young men who spent five years of their lives in a foundry serving their time, and who are now labouring or driving cranes, must influence young men about to embark on a career in the foundry, and cause them to change their minds.

Another contributory factor to this state of affairs is the unwillingness of journeymen to accept apprentices as assistants because of the time required to train these boys, with a subsequent lowering of their output and wages. The point of view of all concerned must be sympathised with, but the time has come when the apprentice problem must be taken seriously.

Metallurgical Advancement

When the electric furnace ceased to be looked upon as a novelty, the path was to some extent cleared for the high-strength cast irons of to-day. These furnaces made melting possible to very close limits and, by using steel mixtures, many low-carbon irons made their way to the market. Tensile strength and other mechanical properties reached heights hitherto thought to belong only to wrought iron and rolled steel.

Castings with metal sections half the size they were once became possible, and to-day

(*Continued on page* 372.)

Vanadium in Cast Iron

By E. PIWOWARSKY

(*Translated from "Die Giesserei."*)

(*Continued from page* 346.)

On comparing different sorts of high-carbon iron, some of which were unalloyed and some alloyed with nickel and chromium, with iron which, by the addition of vanadium-titanium iron, had vanadium contents of 0.15 to 0.51 per cent., together with 0.06 to 0.08 per cent. Ti, the firm of Gebr. Sulzer A.G.[10] found values for the mechanical properties of astonishing quality, while up to 310 Brinell hardness, machining offered no difficulties (Table VI). The author[11] also found very good mechanical properties by employing Norwegian pig containing vanadium and titanium (Table VII) having the following approximate composition:—T.C, about 4 per cent.; Si, from 0.5 to 2.0 per cent.; Mn, 0.2 per cent. max.; P, 0.025 per cent. max.; V, 0.5 per cent. min. (mostly 0.6 to 0.7), and Ti, about 0.5 per cent.

The iron was made by A. S. Bremanger Kraftselskap of Bergen and Christiana Spigerwerk of Oslo in the electric furnace, with the addition of wood charcoal as reducing agent. The ten experimental melts of 150 kgs. each were melted in a 200-kw. high-frequency furnace, cast at 1,350 deg. C. in green sand in the form of test-bars and tested for their properties. The charges contained 0 to 70 per cent. vanadium-titanium iron, the rest hematite iron, silvery iron and sheet-metal scrap, according to the desired composition. Altogether 3,000 individual tests were made. The most important results of the mechanical tests are also given in Table VII. All the alloyed melts exhibited outstanding values for the strength. The value of re-siliconising of grey iron, frequently discussed by the author, is clearly shown by

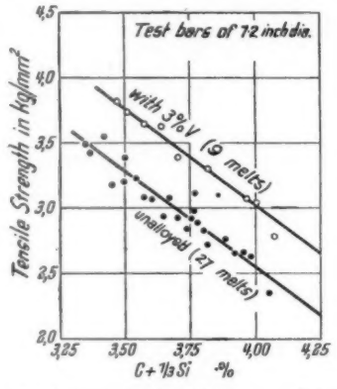


FIG. 6.—INFLUENCE OF VANADIUM (0.3 PER CENT.) ON TENSILE STRENGTH OF GREY IRON. (SCHNEIDEWIND AND MCELWEE.)

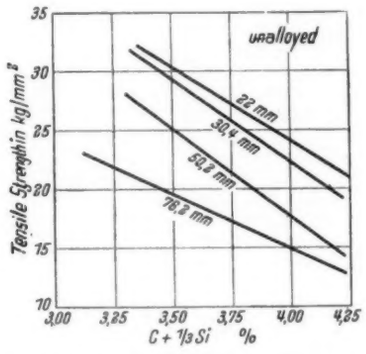


FIG. 7.—TENSILE STRENGTH OF SEPARATELY-CAST TEST-BARS PLOTTED AGAINST CARBON AND SILICON CONTENTS. (SCHNEIDEWIND AND MCELWEE.)

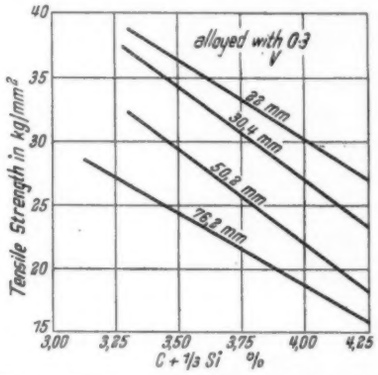


FIG. 8.—TENSILE STRENGTH OF SEPARATELY-CAST TEST-BARS PLOTTED AGAINST CARBON AND SILICON CONTENTS. (SCHNEIDEWIND AND MCELWEE.)

TABLE VI.—*Composition and Mechanical Properties of Alloyed Cast Iron. (Gebr. Sulzer A.G.).*

	Composition.												Mechanical properties.			
	T.C. Per cent.	Gr. Per cent.	Si. Per cent.	Mn. Per cent.	P. Per cent.	S. Per cent.	Ni. Per cent.	Cr. Per cent.	W. Per cent.	Mo. Per cent.	V. Per cent.	Ti. Per cent.	Tensile strength. Kg. per sq. mm.	Transverse strength. Kg. per sq. mm.	Deflection. Mm.	Brinell hardness. Kg.
1	1.53	0.42	2.58	0.51	0.03	0.02	—	—	—	—	0.15	—	63.4	90.0	10.5	338
2	1.55	0.74	2.61	0.94	0.03	0.02	—	—	—	—	0.20	—	55.3	67.5	8.5	335
3																
4	2.58	1.70	2.89	0.29	0.02	0.03	—	—	—	—	—	—	41.2	65.0	10.8	267
5	2.71	2.00	3.00	0.35	0.03	0.02	0.26	0.49	0.37	0.45	0.35	0.06	42.2	67.0	16.5	270
	2.88	1.83	2.51	0.31	0.02	0.03	1.74	0.35	1.73	0.40	0.45	0.07	44.2	—	—	303
6	3.19	n.d.	1.96	0.88	0.40	0.08	—	—	—	—	—	—	31.6	49.5	11.5	238
7	3.22	1.60	1.75	0.57	0.01	0.01	0.18	0.53	—	—	0.50	0.08	40.8	62.5	11.5	310
8	3.42	2.41	0.60	0.32	0.05	0.05	—	—	—	—	—	—	22.2	41.0	10.5	181
9	3.30	2.13	2.02	0.70	0.04	0.06	0.19	0.41	—	—	0.40	0.07	33.8	53.0	10.5	274
10	3.39	2.17	1.85	0.46	0.03	0.02	1.14	0.45	0.77	0.45	0.35	0.06	41.4	66.0	14.5	297
11	3.81	2.67	1.03	0.53	0.02	0.10	—	—	0.69	—	0.51	0.08	22.8	54.0	10.0	265
12	4.14	3.24	1.30	0.93	0.02	0.07	—	—	1.01	—	0.51	0.08	32.4	52.5	11.5	260
13	4.32	3.46	1.42	0.41	0.02	0.05	—	—	0.11	—	0.48	0.08	25.0	46.0	17.5	202

TABLE VII.—(E. Piwowarsky).

Sample.	Vanadium-titanium iron addition.	T.C.	Gr.	C.C.	Si.	Mn.	P.	S.	V.	Ti.	Tensile strength.		Transverse strength.	Deflection.	Brinell hardness.	Impact strength.
											At 20 deg. C.	At 400 deg. C.				
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Kg.	Kg.	Kg.	Mm.		Mkg.
Ti 1	70	3.00	2.22	0.78	1.85	0.39	0.018	0.022	0.45	0.063	32.2	26.5	57.7	14.5	186	1.04
Ti 2	60	3.24	2.40	0.84	2.18	0.60	0.010	0.020	0.63	0.074	29.2	28.7	55.0	10.5	233	0.70
Ti 3	15	3.30	2.60	0.70	2.34	0.54	0.060	0.028	0.15	0.034	28.6	27.2	57.0	14.1	206	0.95
Ti 4	67	2.76	1.96	0.80	2.42	0.35	0.024	0.024	0.45	0.096	33.0	39.2	71.3	12.9	266	0.67
Ti 5	78	2.96	2.16	0.80	2.40	0.64	0.014	0.020	0.56	0.114	29.8	29.4	59.4	8.1	255	0.61
Ti 6[1]	15	2.48	1.98	0.50	2.60	0.43	0.050	0.022	0.15	0.038	23.3	27.4	46.6	6.5	244	0.75
Ti 6b[2]	15	2.48	1.86	0.62	2.82	0.43	0.050	0.022	0.17	0.038	35.2	34.1	72.7	16.6	235	0.86
Ti 7	—	2.78	2.20	0.58	2.30	0.42	0.083	0.024	—	—	21.7	22.1	45.7	7.2	221	0.60
Ti 8	15	2.60	1.96	0.64	1.96	0.52	0.320	0.032	0.14	0.072	28.0	32.2	56.2	8.6	254	0.64
Ti 9[3]	20	3.04	2.28	0.76	1.94	0.40	0.190	0.030	0.19	0.120	36.1	38.0	70.8	13.6	244	0.70
Ti 10[4]	8	2.60	1.80	0.80	2.12	0.40	0.100	0.026	0.49	0.086	34.3	38.4	68.9	11.3	273	0.57

[1] Hard places in parts. [2] As melt 6, but re-siliconised in the ladle with 0.3 per cent. Si. [3] The specimen Ti 9 also contained 0.43 per cent. Cr and 0.94 per cent. Ni. [4] Addition of 0.5 per cent. ferro-vanadium (41 per cent.) in the ladle.

melt 6b in comparison with melt 6. Chromium-nickel additions (melt 9) likewise had a favourable effect. The graphite structure of the alloyed melts was from fine lamellar to fine grain. When employing relatively high contents of carbide-promoting elements, it is advisable to increase the silicon content correspondingly. From the fact that in the case of a cast iron with 2.48 per cent. C and 2.8 per cent. Si for 0.17 per cent. V, the transverse strength rose to 72.7 kg. per sq. mm. and, despite the high modulus of elasticity, the flexibility (high deflection value) was surprisingly great (Table VII), it may be concluded that such a cast iron would be capable of exhibiting high fatigue values, even in the case of local over-stressing, that is to say, for instance, it would be particularly well suitable for crankshafts.

The values shown in Table VIII were obtained by J. Challansonnet[8] for the mechanical properties in the experiments already referred to, which were carried out in the high-frequency furnace with the addition of ferro-vanadium in the series with 2.5 per cent. Si.

vanadium content. Metallographical investigation showed no obvious change in the amount of graphite, but there was some refinement, although slight, of the pearlitic matrix. The graphitisation value was found to be low (−1) throughout.

R. Schneidewind and R. G. McElwee[9] prepared 36 experimental melts in the Detroit electric furnace, and cast them in bars of 22 to 76.2 mm. dia. Tensile strength, transverse strength, hardness, impact strength, influence of the thickness and so forth were studied. According to known suggestions, the tensile strength was plotted against the sum C + ¼ Si, thus showing the effect of increasing or decreasing proportions of solid solutions in the structure. Some of the melts were alloyed with 0.3 per cent. V, and in almost all cases there was an appreciable increase in the strength (Fig. 6), which was more pronounced, the thinner the bars (Figs. 7 and 8). Deflection and impact toughness were scarcely affected, while transverse strength and hardness increased. The vanadium melts also exhibited a much smaller dispersion of the values for the tensile strength, which is equivalent to an improvement in the "accuracy of aim." Although in numerous cases, the increase in strength due to the vanadium additions may be explained, in order of magnitude, as resulting from the combining of a corresponding amount of carbon, in the case of the work under discussion, the increase in strength was too pronounced to be accounted for merely by a removal of carbon calculated on the basis of V_4C_3. It is consequently necessary to assume that the vanadium exerts a certain influence on the matrix or graphite formation which would appear to confirm the previously conjectured reaction of the vanadium carbides, already separated in the molten mass, on undercooling during the eutectic crystallisation.

(To be continued.)

TABLE VIII.—*Mechanical Properties of Cast Iron Alloyed with Nickel and Vanadium* (Challansonnet).

T.C. Per cent.	C.C. Per cent.	Si. Per cent.	Mn. Per cent.	Ni. Per cent.	V. Per cent.	Compression strength. Kg. per sq. mm.	Transverse strength. Kg. per sq. mm.	Brinell hardness. Wall thickness (sand).				
								31 mm.	18 mm.	12 mm.	6 mm.	3 mm.
2.50	1.50	2.50	0.50	—	—	112.0	66.0	301	306	405	520	600
2.48	1.30	2.45	0.48	0.98	—	126.0	70.0	251	265	298	351	375
2.50	1.20	2.43	0.50	1.98	—	127.0	72.0	277	298	340	405	430
2.42	2.20	2.41	0.45	—	0.28	142.0	91.0	461	521	583	652	—
2.35	2.30	2.38	0.43	—	0.59	145.0	95.0	512	560	602	—	—
2.45	1.90	2.40	0.46	1.01	0.27	132.0	72.0	313	435	473	552	650
2.49	2.00	2.42	0.51	1.03	0.50	134.0	74.0	330	445	480	560	650
2.44	1.85	2.40	0.42	2.06	0.28	138.0	76.0	360	407	438	495	558
2.40	2.03	2.60	0.40	1.97	0.53	141.0	76.0	401	421	450	474	505

TABLE IX.—*Results of Analytical and Technical Investigations.*

	C. Per cent.	Si. Per cent.	Mn. Per cent.	P. Per cent.	S. Per cent.	V. Per cent.	Transverse strength. Kg. per sq. mm.	Deflection. Mm.	Tensile strength. Kg. per sq. mm.	Brinell hardness. Kg. per sq. mm.	Shrinkage cavities. Per cent.	Length of spiral. Mm.	Temperature on addition. Deg. C.
I	3.22	1.69	0.42	0.52	0.12	—	48.3	13.1	28.0	230	4.48	760	1,340
						0.17	49.8	13.2	29.85	238	4.18	650	—
						0.21	49.9	13.4	29.2	239	4.08	630	—
						0.42	55.7	12.8	32.95	263	n.d.	560	—
II	2.79	1.87	0.29	0.16	0.069	—	54.3	13.2	29.5	266	3.27	650	1,390
						0.12	55.5	12.6	31.6	280	3.15	600	—
						0.22	57.2	12.8	33.8	287	2.95	550	—
						0.27	62.5	14.3	35.7	290	2.65	400	—
III	3.36	1.42	0.41	0.44	0.131	—	42.3	12.5	22.0	226	2.86	750	1,335
						0.145	46.0	12.5	22.6	229	2.42	600	—
						0.172	46.2	12.5	23.5	240	2.30	550	—
IV	3.22	2.43	0.40	0.53	0.104	—	37.7	13.2	20.0	224	2.42	850	1,345
						0.12	41.8	13.9	20.6	229	2.33	740	—
						0.26	44.8	13.7	22.7	243	2.19	700	—
						0.37	48.8	12.6	24.4	Defective.	n.d. Internal cavity.	640	—
V	3.37	1.88	0.53	0.44	0.099	—	n.d.	n.d.	22.9	n.d.	n.d.	780	1,335
						0.13	—	—	22.9	—	—	740	—
						0.18	—	—	25.3	—	—	660	—
						0.28	—	—	24.0	—	—	640	—
VI	3.15	1.34	0.80	0.46	0.13	—	52.1	12.7	28.7	213	n.d.	n.d.	1,340
						0.12	53.0	12.2	30.1	219	—	—	—
						0.20	54.3	11.2	31.1	229	—	—	—
						0.28	51.2	8.9	31.0	236	—	—	—

It will be seen that with such low-carbon melts, even 0.3 per cent. V was sufficient to cause the iron to be practically white. Nickel additions appreciably counteracted the strongly carbide-promoting influence of vanadium. The transverse strength of the mainly white specimens is surprisingly high. Vanadium cast iron appears to be inferior to nickel cast iron with regard to wall thickness sensitivity, as far as hardness is concerned.

The Mitteldeutsche Stahlwerke[10] reported the results for five different sorts of cast iron melted in the cupola, and a further cupola melt subsequently superheated in the oil furnace for 70 min. at 1,500 deg. C. Alloying was effected with powdered ferro-vanadium containing about 60 per cent. V and 1.2 per cent. Si, and practically free from carbon. The experimental results (Table IX) show in general an increase in the transverse strength, tensile strength and hardness. The deflection showed either no improvement or, from 0.10 per cent. V and upwards, even a slight reduction. There was, surprisingly, less tendency to cavity formation (deoxidation?), while the casting ability ("life"), measured by means of a spiral of 50 sq. mm. cross-section, decreased considerably with increase in the

Patent Specifications Accepted

The following list of Patent Specifications accepted has been taken from the "Official Journal (Patents)." Printed copies of the full Specifications are obtainable from the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1s. each. The numbers given are those under which the Specifications will be printed and abridged, and all subsequent proceedings will be taken.

524,970 WELLMAN SMITH OWEN ENGINEERING CORPORATION, LIMITED, and SCHIELDROP, B. H. Furnaces for the heat-treatment of metal objects.

525,011 GROVES, W. W. (Monsanto Chemical Company). Pickling steels and baths therefor.

525,021 S.O.C. D'ELECTRO-CHIMIE, D'ELECTRO-METALLURGIE, ET DES ACIERIES ELECTRIQUES D'UGINE. Moulds for casting metals or alloys.

525,053 BRITISH THOMSON-HOUSTON COMPANY, LIMITED. Electric welding-machines.

525,113 BRASSERT & COMPANY, LIMITED, H. A. Method of controlling the temperature of industrial furnaces.

525,153 TURNER & NEWALL, LIMITED, TURNER, L. A., and WRIGHT, H. LAW-. Pipe joints.

525,160 WILLIAMS, W. P. (American Rolling Mill Company). Hot coiler and method of hot coiling.

Dendritic Structure

DR. C. H. DESCH'S ADDRESS TO SHEFFIELD METALLURGICAL ASSOCIATION

(*Continued from page* 351.)

Dendrites in Alloy Steels

In alloy steels there was a further significance of this dendritic structure. Not only such an element as phosphorus was unevenly distributed throughout the dendrite, but also the alloying elements—the proportions of chromium, nickel, molybdenum and so on—were not constant throughout the breadth of a dendrite. They had a change in concentration as they proceeded from the central core to the periphery. That meant that with a different composition the different portions of the dendrite had different transformation points, and it did seem likely that this fact of different critical points for the interior and the exterior, different rates of transformation in an isothermal change and so on, might play a very considerable part in the production of internal stresses and cracks, and no doubt that had a great deal of importance.

Now the degree of non-uniformity of composition within the dendrite depended very largely on the distance between the liquidus and solidus in the particular system, also on the rate at which diffusion could take place in the solid. If they took the case of iron and manganese they found the liquidus and solidus were very close together. Usually they did not expect, in a simple iron-manganese alloy, to find very strong differences of concentration between the interior and the periphery of a dendrite. On the other hand, with chromium they had a very wide gap between the liquidus and solidus, and therefore they found a much bigger difference. With carbon and phosphorus they had quite a considerable distance between liquidus and solidus, and therefore a considerable liability to this dendritic structure.

Composition Gradient of Alloy Dendrites

Continuing, the speaker pointed out, and illustrated with slides, that a dendritic structure might be developed even when the quantity of impurity was extremely small. The speaker went on to say that it was thought it would be of interest to the committee to have some experimental work done to determine what was the actual composition gradient within the dendrites of certain actual alloys. He had made a note of eleven methods that might be used for that purpose. They were as follow:—Chemical etching; contact printing; microchemical examination of shavings; spectrographic study of isolated spots; determination of electrolytic potential at points; measurement of the electrolytic potential as a whole; X-ray microscopy; X-ray transmission pictures: the thermo-magnetic method; electrical resistance: and the broadening of X-ray lines. Some of these methods could certainly give quantitative information.

Taking first the method of chemical etching, that was the method generally used for steels. If they wanted to show up the dendritic structure of steel they used one of the copper reagents, which showed not only the distribution of phosphorus, but also other elements producing non-uniformity of composition. For many other alloys, various macro-reagents had been developed which would show up the dendritic structure for those particular alloys. For every alloy they had to have some specific reagent.

It was not very easy to start on steel. In steel, of course, the amount of carbon and phosphorus was small, so that the difference between the interior and the exterior would also be small. It seemed advisable to start with something rather simpler, and the alloy that they took for this purpose was cupro-nickel. Copper and nickel formed in equilibrium a series of homogeneous solid solutions, but if cooled at all rapidly—in fact in all cases unless one cooled with extreme slowness—they got a composition gradient within the dendrites, and one could etch that very conveniently.

Measuring Diffusion

In Sheffield some years ago, when he (the speaker) was working on the diffusibility of copper in nickel with Dr. J. W. Jenkin, the latter suggested a method of measuring the rate of diffusion. They took a number of alloys of copper and nickel differing by 10 per cent., starting with pure copper, then 10 per cent. of nickel, 20 per cent., 30 per cent., 40 per cent., and so on, up to pure nickel. These were made into rectangular blocks, thoroughly annealed so as to make them quite homogeneous, and then clamped together and mounted in white metal protected by means of a varnish, so that they could be etched without any decided electrolytic effect. If they put a block like that into a ferric-chloride solution of definite concentration and left it in for so many seconds, they would find that, starting from the copper end, it had etched the 10 per cent. but had not etched the 20 per cent. If they kept it in longer it would etch the 20 per cent. but not the 30 per cent. And so they could go on; they got a time-curve representing these steps of 10 per cent. If they took their cored specimen and put it into the same solution at the same time they would find a certain structure (illustrated on the screen) with a sharp boundary. They could measure the area of black and white on the negative or the print, as they preferred, and they said that that boundary then corresponded with, say, 20 per cent. of nickel. They then went on for a further period until the etching had gone as far as 20 per cent.; they again took this out, washed it and photographed it, and in that way they mapped out the concentration gradient within the specimen.

Later, at the National Physical Laboratory, they obtained a curve from a 50 per cent. copper-nickel alloy which was taken in the cored condition, and it was compared with a block of eleven specimens which had been annealed so as to be homogeneous, and after immersing a certain time one obtained a number of points. The actual experimental points lay pretty well on those curves, although of course their test block was only made of ten steps. To get a smooth curve, one should actually of course use much closer steps, but the two did agree very well, and in that way one was able to map out the change of concentration of copper in nickel in those dendrites. They found, of course, that with a 50 per cent. alloy the interior was quite high in nickel and the exterior was much poorer.

They carried out a similar series of experiments with a copper-antimony series, but as the range of solid solutions there was much smaller they used steps of 1 per cent. instead of 10 per cent. They got very similar results.

That was a way that he thought was capable of further development. It was not very difficult to carry out, and owing to the peculiar property of cored solid solutions of etching as if there were a sharp boundary between the black and white portions it was quite easy to make the measurements. It was going to be rather difficult to make similar experiments with steels. One would have to start, he thought, with a series of iron-phosphorus alloys, and that had not yet been done. If, instead of being a complete solid-solution series, it was a eutectiferous series such as Gulliver was discussing, the effect of this imperfect equilibrium was to have a eutectic appearing in an alloy that should show no eutectic, or they might get a new phase appearing when, according to equilibrium, there should not be one, and he thought that accounted for some of the facts which had been used by other people in the case of steels as evidence for the existence of a liquid immiscible phase.

Contact Printing

The second method that he had mentioned was that of contact printing, the most familiar instance of which was the sulphur printing of steels. There, one got the dendritic structure, not because of an etching of the dendrites themselves, but because one got a picture of the distribution of the sulphide particles which occupied the spaces between the dendrites, so that they had the dendrites mapped out but not a gradient within the dendrites themselves. They had made some experiments in that direction with iron-nickel alloys. Using a reagent which would show the presence of nickel, one could make contact prints. The method which they found to be best on the whole was to use a glossy gelatine paper impregnated with a dilute acid, and a nickel reagent. That was pressed down on to the still unpolished specimen in the ordinary way as when making a sulphur print, an aluminium plate was laid on that, and a small voltage applied. In that way they were able to get fairly good reproductions of any coarse structure like a meteorite, but within the ordinary range of composition of iron-nickel alloys the difference was not enough. He thought it was possible that something might be done to perfect that method, but it was a matter of finding just the right conditions of concentration and so on.

A method of study which should be extremely useful and simple would be, if one had specimens of a really coarse dendritic structure, to use a very fine engraving tool and take very minute shavings from the core and from the periphery of dendrites. Seeing that, with modern microchemical methods, they only wanted a tenth of a milligram for an analysis, it was possible to get suitable shavings within the limits of a single dendrite. They had been waiting for specimens of that kind, but had not been successful in getting them yet, because unfortunately the big ingots which would show structure of that kind were nearly always either put through an annealing treatment or left so long in the soaking pit that the composition was very largely equalised. For practical purposes they wanted it equalised, but for this test one would like to have specimens which had not been treated in that way.

Spectrographic Study

The spectrographic study of spots was possible. With modern spectrographic technique it was possible to isolate small spots and get the composition. Whether the spots could be made small enough to work out the dendritic structure with the required degree of accuracy, he was not sure. Mr. Barker was doing that kind of work, and very skilful spectrographic workers might be successful in that way.

Portevin mentioned the determination of electrolytic potential at isolated points as a possible way of studying structures of this kind, and said that Le Chatelier made some experiments of that nature. He (the lecturer) could not find records of this work in any of Le Chatelier's Papers, and he doubted whether

the method would be satisfactory, as it was almost impossible to get consistent results with point determinations of potential.

The measurement of the electrolytic potential as a whole was applicable in determining the equalisation of structure during annealing. As the solid solution became more uniform its electrolytic potential changed, but he did not think that they would be able in that way to determine the composition gradient within the dendrite.

X-Ray Microscopy

For the method of X-ray microscopy, Mr. von Hamos had devised an instrument which he called the X-ray microanalyser, and it was a very ingenious method indeed. He used a reflector, or mirror, for the X-rays, which consisted of a half-cylinder calcite crystal. If a beam of X-rays were made to fall on the specimen, it could be focused by means of this rather peculiar mirror and made to fall on a screen which, placed at the proper angle, would produce an image. That image might be magnified, but as the magnification was increased the image became more distorted. Apparently the best results were got by using no magnification, but reproducing the image of the same size as the original object, and then magnifying the photograph obtained. As those objects, Mr. von Hamos used blocks made up of thin foils of different metals, packed together, and in that way he got really excellent reproductions of these, each foil radiating differently when bombarded with X-rays, producing its own effect. He was also able to take some alloys, including the iron-chromium alloy, and to show the gradient in the iron-chromium solid solution, the portions rich in chromium giving a different depth on the photographic plate. It should be quite possible, using a photometer to measure the density on the plate, in that way to get the gradient. He had not seen that anyone had applied this method yet, but it looked an undoubtedly practical one.

Other Methods

There was the question of X-ray transmission pictures, the ordinary shadow photographs taken in examining castings. It was a rather curious fact that, long before X-rays were used for examining metals technically, Heycock and Neville tried this method, just after the discovery of X-rays. They took a series of alloys of gold and sodium, because the densities and absorptive powers of gold and sodium differed so much. They got thick sections, allowed X-rays to pass through them, and took an ordinary X-ray photograph underneath, and the crystals of the gold-sodium compound showed up. They were not nearly as good pictures as one could get by the ordinary micrographic method, because, of course, the section had a certain thickness, and so there was some blurring of the image, and the method did not seem to be of much use. Rather remarkably, within the last year or two it had been taken up again, in the laboratory of the French Ministry of Air, and in that laboratory they had obtained some very good photographs with some of the light alloys. Using modern sectioning methods, cutting very thin slices and using transmission pictures of X-rays, they had got quite good pictures of those crystals of higher absorptive power which were embedded in the light alloy. He did not think, however, that this method would be good enough for examining the composition change in solid solutions.

The next method was that of using thermo-magnetic curves. That was the method that had been employed, particularly by Chevenard. It was only applicable to a limited number of alloys, to those of the ferro-magnetic metals in which the Curie point—the point at which the ferro-magnetism disappeared on heating—varied markedly with the composition. The work that Chevenard had published had dealt with rather complex steels. They were ferro-nickels containing some tungsten, and the method was to determine the magnetism-temperature curve for an alloy in its unannealed condition and then to compare that with the condition after annealing.

In the same way the process of annealing might very conveniently be varied by determining either the electrical resistance or the change in the breadth of the X-ray lines in the ordinary X-ray pattern. A good deal of work had been done on that, and one could measure the rate at which the alloy became homogeneous. But those methods did not lend themselves nearly so well to the determination of the gradient, except that of course one might make a number of comparative specimens and find the time taken for homogeneity to be reached when other conditions were the same.

These were the methods that might be applied. His address was only just a preliminary account, which was prepared really for the Ingots Committee, of methods that might be employed and that seemed more or less promising. He thought that chemical etching, as with the cupro-nickel experiments, might be developed a good deal. The use of a reference block of the kind described, making the steps, of course, quite small instead of the crude 10 per cent. steps, might be very well applied to the determination of the actual variation of composition within dendrites, even in alloys.

Then he should like to see some experiments done on the actual examination of shavings taken from large dendrites, preferably dendrites in the upper part of a big ingot, using micro-chemical methods. Two other methods were worth trying. Chevenard's thermo-magnetic method was only applicable to a very limited number of alloys, but might be useful for them, and he thought Von Hamos' X-ray instrument had distinct possibilities. It was quite possible that that might be improved in such a way as to give a more magnified image. He must say that the photographs which had been published were quite surprisingly sharp, and it should be possible, with the use of a photometer, to get an accurate measurement of the change of composition within the dendrite.

As he had said at the outset, change of composition within the dendrite really had a considerable practical importance. One always aimed at getting rid of the dendritic structure as much as possible in forging, and in the case of alloy steels one certainly would like to get rid of it from the point of view of the prevention of cracks in those steels which were liable to develop them.

Concluding, the author said that his address was not to be regarded as a Paper but a sketch. He put it forward as a basis for discussion, and he hoped it would be possible not only for further work to be done but for suitable material to be supplied.

Old Linen Tracings for War Use

Old linen drawings and tracings can easily be utilised for the making of all kinds of articles such as surgical war stores, where the use of fine linen is necessary, and the Women's Voluntary Services headquarters request that all available tracing linen should be collected for use. It is asked that old tracings, etc., should be addressed to Mr. F. R. Yerbury, Director, The Building Centre, 158, New Bond Street, London, W.1.

Uses of Rubber-Coated Metals

According to MR. H. E. COOK, rubber coatings on metals are being successfully used for such applications as tank cars; storage and pressure tanks; fan housings and blades; agitators; pumps; rubber tracks for tractors; motor mountings; bumper blocks; vibration dampeners; water-lubricated bearings for boat propellers; hydrochloric-acid and other pickling and plating vats, and ash-handling equipment.—"Metal Progress."

War-Damaged Property

LEGAL IMPLICATIONS

With damage to property from war action becoming more frequent, it is thought that an explanation of the Landlord and Tenant (War Damage) Act, 1939, may be useful, as this measure has been passed to meet the circumstances of war damage, and questions arising therefrom between landlords and tenants.

Obligations to Repair

This Act provides that, notwithstanding any arrangement—written or oral—concerning the person responsible for repairs, any obligation to repair is not to have legal effect as far as any damage caused by war action. Furthermore, if any damage other than war damage necessitates repairs, and owing to the extent of the war damage it is impracticable or only practicable at an unreasonable cost to execute these, or such repairs would give no substantial advantage to the person entitled to benefit (*e.g.*, landlord), the obligation to repair such damage is to be suspended until the war damage is made good.

By this Act, if premises suffer war damage it is obligatory upon the tenant or mortgager, where there is an obligation in the lease or mortgage to undertake repairs, to notify the landlord or mortgagee as soon as possible of the damage, and as far as possible give the general nature of the damage, and also to allow access to the premises by the landlord or mortgagee (or authorised representative).

Making Premises Fit for Use

Although any obligation to repair does not apply so far as war damage, this Act introduces special provisions for leaseholds (where ordinarily the tenant would be responsible for repairs) as regards making fit for use premises made unfit for use by war damage.

The tenant can serve upon the landlord a "notice of disclaimer," meaning that he elects to disclaim the lease, or a "notice of retention" meaning that he elects to retain the lease on certain terms (explained in the following paragraph).

If a notice of disclaimer is sent and accepted by the landlord, this amounts to a surrender of the lease, and the tenant has no further interest or responsibility in the matter; if a "notice of retention" is served, this means that the tenant accepts the responsibility of making the premises fit for use, but no rent is payable until the premises are made wholly fit for use, although if part of the premises can be used, a rent proportionate to the part fit for use may be payable.

An important point to note, however, is that if a landlord wishes to keep a lease alive, he is not obliged to accept a disclaimer notice; he can himself serve a notice called "a notice to avoid disclaimer." This means that the landlord then undertakes to make the premises fit for use, as soon as possible, and no rent is to be payable until the premises are made wholly fit for use, but if part of the premises is considered as being capable of beneficial occupation, a rent proportionate to that part may be payable.

Another point which is covered is that if a tenant sends no notice at all, the landlord can serve on the tenant a notice called "a notice to elect," and, if no reply is received within a month, it is to be assumed that a "notice of retention" has been sent.

Provision is made for a court (*i.e.*, County Court; in some cases High Court) to decide questions where it is claimed that the premises are not rendered unfit by war damage; this applies where a lessor claims that a disclaimer notice has no effect by reason of this fact, and also similarly where a tenant claims that a notice to elect should not apply.

Protection from Glass Fragmentation

The Ministry of Labour and National Service has issued a statement for the guidance of occupiers of works employing 250 or more and engaged on work of national importance, to advise them on the best methods of meeting dangers from broken glass from roofs, having regard to the need for admission of daylight and preservation of the black-out, and also to the availability of materials. It is not suggested that the measures recommended are the only adequate measures. Other measures will doubtless become available; and there is no need to alter existing arrangements provided they afford effective protection.

Replacement

The safest course is to take out the glass and substitute non-splintering materials, and this can be done more freely if suitable proprietary or other translucent materials are used. Textile substitutes are suitable for side windows and internal partitions, but stronger materials are needed for the replacement of roof glass.

In so far as glass can be replaced by opaque materials without undue loss of daylight, window openings can be bricked up or the glass, whether in windows or in roofs, can be replaced by various light-weight materials (if weather resisting).

Protection

In considering the steps needed for the protection from glass not replaced by other materials, it is first necessary to consider how far the glass can be obscured. No complete scales can be laid down in regard to this. As a general rule, however, the total amount of daylight-admitting roof glazing in workshops can (if the glass left clear is so chosen as to allow a reasonably uniform distribution of daylight) be limited to 12 per cent. of the floor area, or less in appropriate cases. In the case of vertical lights, a higher proportion may be necessary.

Methods Recommended

(1) *For Roof Glass which can be Permanently Obscured.*

Fabric bitumen treatment should be applied. This consists of sticking a textile fabric to the outside of the glass with bituminous adhesive and, after the latter has dried, applying a second bituminous coat. This treatment should extend over the glazing bars, but the fabric should everywhere be in close contact with the glass. The treatment should conform with British Standard Specification BS/ARP.48.

Plain glass so treated will probably hold together for a few days after it is broken by blast, but eventually pieces will fall unless additional protection is provided. For this purpose 2-in. mesh wire netting or ¼-in. mesh expanded metal can be used.

If the glass is wired glass, fabric bitumen treatment properly applied should ordinarily hold broken panes in place for a considerable period, and sufficient additional protection can be provided by: (i) 2½-in. mesh three-ply netting of sisal, hemp, or jute, securely laced to the roof structure either close under the glass and completely covering it, or at eaves level over the whole area of the workshop; or (ii) cross-bars at not more than 2-ft. centres (BS/ARP.48, Appendix G).

(2) *For Roof Glass which must be Kept Clear.*

Wire netting of not more than 1-in. mesh, or ½-in. mesh expanded metal, should be fitted closely under plain glass. Under wired glass, 2-in. mesh wire netting will afford sufficient protection.

(3) *For Vertical External Glass.*

Plain Glass.—(*a*) If it can be wholly obscured, vertical external glass should be treated with fabric bitumen as above. Alternatively, stout paper may be pasted to the glass on the inside, provided the whole of the glass surface is covered. (*b*) Where the glass cannot be wholly obscured, the glass and framework should be covered on the inside with reasonably strong fabric such as textile netting, muslin or cheese cloth, secured by a suitable damp-resisting adhesive. (*c*) If it is essential to admit as much daylight as possible, the glass should be screened on the inside with ½-in. or ¼-in. mesh wire netting or ¼-in. mesh expanded metal.

Wired Glass.—Panes less than 4 sq. ft. in area need not be treated, but larger panes should be protected in the same way as plain glass, except that in case (*c*) 2-in. mesh wire netting or ¼-in. mesh expanded metal will afford sufficient protection.

(4) *For Internal Glass in Partitions, Screens, Doors, etc.*

Ordinarily such glass can and should be removed. If plain glass cannot be removed, it should be treated as at (*b*) above, or, if it must be kept clear, protected on both sides as at (*c*). Small panes of wired glass need not be treated.

Camouflaged Buildings

Schemes of camouflage usually allow for unpainted areas of vertical glass appearing as dark patches. Adhesive netting may cause these areas to appear white, unless black netting is used.

Workmanship and Maintenance

Wire netting or expanded metal must be securely fixed all round, so that it will not be displaced by blast. Under sloping roof glass, the lower edge must be so secured as to support the weight of broken glass which might slide down the netting. Fabric bitumen or other materials attached to the glass by adhesive should be so fixed as to adhere to the whole surface of the glass and overlap the supporting framework.

Protective measures should be inspected once a month to ensure that they remain effective. Adhesive treatment which shows signs of deterioration should be renewed or made good, and wire screens should be examined for rust and to ensure that the fixings are secure.

Factory occupiers desiring further information or help in selecting suitable adhesive materials or glass substitutes, translucent or otherwise, may apply to the local Factory Inspector, or, in the case of factories where air-raid precautions are supervised by the Passive Air Defence Departments of the Admiralty, Ministry of Aircraft Production or Ministry of Supply, to the officers of those departments. If special technical difficulties are encountered, the advice of the Research and Experiments Department of the Ministry of Home Security may be sought through the Factory Inspector or through the officers mentioned above.

Molybdenum in Cast Iron

Amongst the many developments in cast iron calling for the use of molybdenum in both as-cast and heat-treated irons is a molybdenum-vanadium iron which has exhibited unusually high strength with low hardness and good machinability. This information is given by ALVIN J. HERZIG in a contribution to "Metal Progress." He cites as commercial applications cylinder heads, timing gear and manifolds. An interesting comment made by this author is that the use of molybdenum irons for flame-hardened dies and lathe beds is increasing in American foundry practice. This innovation is possibly due to the fact that under some circumstances adequate depth hardening can be obtained without a water quench. Remarkable service tests have been given by Wheelabrator-type blades made from irons containing 10 per cent. molybdenum.

Correspondence

[*We accept no responsibility for the statements made or the opinions expressed by our correspondents.*]

Cost Price and Profit

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—My company has been asked to take certain jobs at 7 per cent. profit on cost price. On such work the cost of labour and material is easily ascertained.

Difficulty may arise in agreement on overhead charges. The figures given by our accounting department up to the end of September last for the previous year are:—

	A. Per cent.	B. Per cent.
Salaries	6	5¼
Trade expenses	7½	7¾
Depreciation	1	1
	14½	14

"A" refers to work chiefly foundry, machining castings and some structural work, "B" to a speciality *not* including foundry work.

These percentages are based on the net sales per annum, which are somewhat under £100,000 in each case, and in each case the turnover is roughly the same as the capital employed in the department.

We are wondering whether any of your readers would care to give their figures for a recent trading year.

Based on the *cost of wages and materials* purchased, the trade expenses run out somewhere about 20 to 21 per cent. In both cases a rough profit of 10 per cent. is realised on the turnover of sales.

Directors' fees have not been included in the trade expenses. The managing director gets a small salary and commission, and his commission has not been included in the trade expenses.—Yours, etc.,

A PAST-PRESIDENT, I.B.F.

New British Chemical Standards

The Bureau of Analysed Samples, Limited, whose business has been transferred from Middlesbrough to Markington, near Harrogate, announces two new analytically-standardised samples.

B.C.S. Ferro-Manganese No. 208 has the following percentage composition:—Mn, 78.00-; Fe, 13.37-; C, 6.58-; Si, 1.27-; S, 0.014; P, 0.237; As, 0.027; Ti, 0.082; Cu, 0.025; Ni, Co, Mo, Cr, Al and V, traces; O, by difference. This sample is typical of the type manufactured in blast furnaces in this country, and is particularly useful as a standard for manganese and phosphorus. The accurate determination of phosphorus in ferro-manganese calls for certain precautions peculiar to this type of alloy. Details are given on the certificate of analyses.

B.C.S. Stainless Steel No. 209 has the following percentage composition:—Cr, 18.70-; Ni, 8.30-; Ti, 0.59-; C, 0.11-; Si, 0.19-; S, 0.029; P, 0.019; Mn, 0.39-. This sample is of the 18:8 type incorporating titanium. The certificate of analyses includes modern methods for Cr, Ti, and Mn.

Each sample has been analysed by experienced chemists representing well-known manufacturers as well as independent chemists and users, including (in the case of the stainless steel) the Ministry of Aircraft Production. Each bottle of standard material is provided with a certificate of analyses showing each co-operating chemist's figures, including an outline of his methods of analysis. Supplies may be obtained direct from the Bureau of Analysed Samples, Limited, at their new address, or through any of the usual laboratory furnishers.

Relation of Defects in Enamel Coatings to Hydrogen in Steel

By C. A. ZAPFFE and C. E. SIMS

(*Continued from page* 308.)

The foregoing hypotheses regarding the effect of hydrogen on enamel coatings can be quite easily proved true by simple experiments. All specimens in the following experimental work were prepared by using the standard enamelling procedure outlined in discussing Fig. 12 unless otherwise noted. Pickling times varied between 15 and 30 min., depending on the requirements of the specimens. Variations in the pickling time, of course, will cause only unimportant quantitative variations in the results.

In the present experiments, ordinary steel, which contains 0.15 to 0.20 per cent. carbon, was used instead of the usual low-carbon enamelling stock. With a suitable understanding of the functions of hydrogen in steel, it is possible, as will be shown, to disregard moderate carbon contents of the steel and still obtain enamel coatings that are free from the defects under consideration.

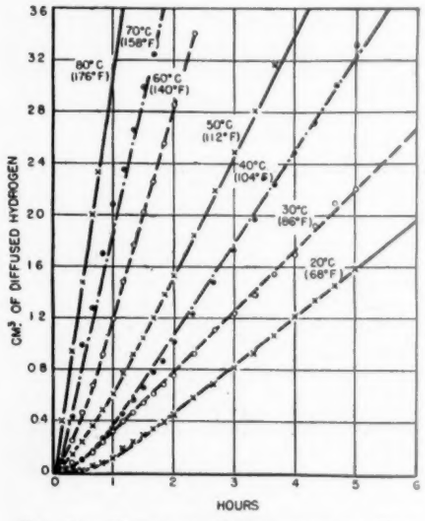


FIG. 14.—EFFECT OF TEMPERATURE ON DIFFUSION OF HYDROGEN THROUGH 9 SQ. IN. OF 0.05-IN. STEEL SHEET (BARDENHEUER AND THANHEISER). HYDROGEN GENERATED BY 20 PER CENT. (BY VOL.) H_2SO_4.

(2) Blistering Caused by Hydrogen in Simple Solution

From Figs. 14 and 15, a fair conception may be obtained of the diffusibility of hydrogen that is dissolved in steel. Fig. 14 shows that as the temperature increases from room temperature to 80 deg. C., the quantity of hydrogen that will diffuse through a given thickness of steel increases about thirty-fold. This conforms with the effusions shown in Figs. 6 and 12. Fig. 15 shows the marked effect of thickness of the metal section on the diffusion of hydrogen.

To find, experimentally, the time and temperature of drying or ageing necessary to eliminate hydrogen held in simple solution in the steel, a rough wedge of plain carbon steel was covered with a blue ground coat and given a total drying period of 30 min. at 115 deg. C. before firing at 870 deg. C. The result is shown in Fig. 16.

It is seen that the enamel fused quite smoothly from the thin top down to where the steel was about $\frac{3}{16}$ in. thick. In thicker sections, the dissolved hydrogen did not have time to leave the steel completely during the ageing period of 30 min. Of course, the distribution of the blistering may also be attributed to resolution of the hydrogen in the thinner section where the metal had come to temperature, as heavier sections heated more slowly and hence remained longer at temperatures where hydrogen is evolved and not dissolved. Specimens in the present investigation, however, were fired in a furnace that permitted observation of the firing process, and the thin section did not show the boiling that characterised the thicker section.

This one specimen therefore portrays in a new light the "boiling-down" period that must be allowed for obtaining a satisfactory coating. Heretofore the boiling and bubbling have been generally regarded to be a result of chemical reactivity between the iron, particularly carbon in the iron, and the enamel. No explanation has been advanced to account for the fact that the bubbling subsides and will not recur until the specimen is first cooled nearly to room temperature. Numerous investigators have suggested that the gas comes from the metal, and the gaseous evolution has been shown to be quite independent of the coating. Slow heating, furthermore, prevents reboiling. Other observations corroborating the hydrogen theory have already been discussed. Some of the boiling action, of course, is due to the reactivity of iron with moisture, as explained, and that action was observed to be progressing weakly in the tip of the wedge. The strong boiling in thicker sections was due primarily to evolution of hydrogen that had dissolved into the iron during pickling. Regardless of the source in either case, the offending gas is hydrogen, and it is most likely that the tiny bubbles that act to opacify ground coats are also caused by hydrogen.

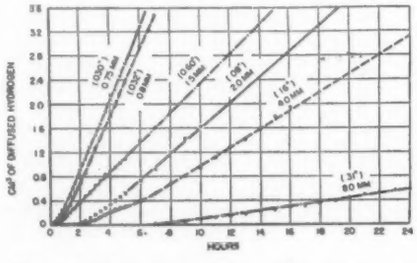


FIG. 15.—EFFECT OF METAL THICKNESS ON HYDROGEN DIFFUSION AT 25 DEG. C. THROUGH 9 SQ. IN. OF STEEL SHEET (BARDENHEUER AND THANHEISER). HYDROGEN EVOLVED BY 20 PER CENT. (BY VOL.) H_2SO_4.

This wedge further demonstrates the reason why enamelling defects, and hydrogen defects in general, bear a strong relation to the microstructure of the steel. A longitudinal section through the wedge would show, of course, a variation in structure corresponding to the variation in temperature and in heating and cooling rates; when steel transforms, the solubility of hydrogen is also markedly altered. The relation, then, of microstructure to enamelling defects is often only coincidental.

The practical result of the experiment showed that hydrogen in simple solution in this steel will not cause blistering in specimens that have no section thicker than $\frac{3}{16}$ in. if the specimen, after pickling, is aged 30 min. at 115 deg. C. To demonstrate the severity of the action that may result from this dissolved hydrogen if it is not properly removed from the steel, a $\frac{3}{16}$-in. plate of ordinary steel was coated with enamel and fired at 735 deg. C. after only 5 min. of baking at 115 deg. C. The result is shown in Fig. 17.

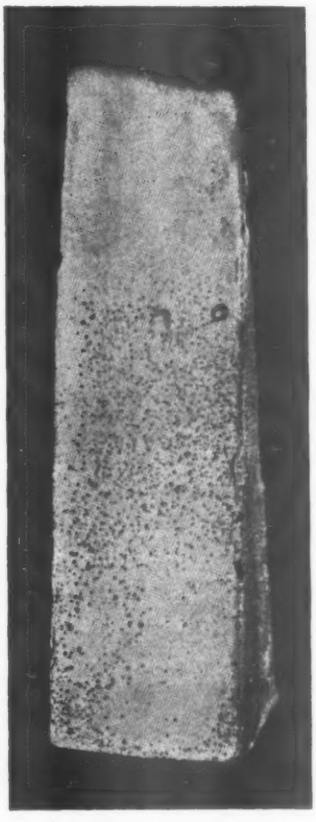


FIG. 16.—WEDGE OF PLAIN CARBON STEEL FIRED WITH BLUE GROUND COAT 5 MIN. AT 870 DEG. C. AFTER AGEING FOR 30 MIN. AT 115 DEG. C.

The hydrogen in these tests, of course, is almost entirely derived from the pickling operation in the cleaning treatment. The severe gas

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effusion that ruined the coating on the specimen shown in Fig. 17 cannot possibly be due to the carbon-oxide reaction, for the firing temperature was only 735 deg. C. Note that this firing temperature is so low that very little hydrogen can dissolve in the steel. Correspondingly, the effusion was most severe and did not subside during the 9-min. firing period nor for some days after cooling. The specimen stood at an angle in the furnace, and when the enamel fused, blisters formed that were so large they literally hung from the underside of the piece as large, gas-filled droplets. On both sides of the specimen, parts of the coating were completely removed from the steel during firing, as is evidenced by the visibly oxidised areas shown in the figure; and, as the piece cooled, other

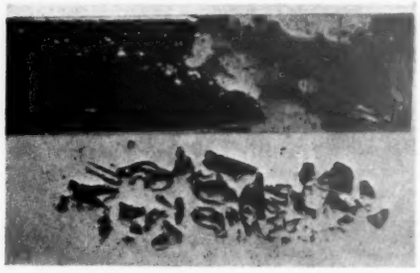


FIG. 17.—WALNUT COATING FIRED 9 MIN. AT 735 DEG. C. ON $\frac{3}{16}$-IN. STEEL AFTER BAKING ONLY 5 MIN. AT 115 DEG. C.

large pieces of enamel were exploded away by hydrogen that continued to evolve. As may be seen in the figure, the evolution of hydrogen was so severe during firing that no oxidation and no bonding occurred.

An identical plate was similarly treated, except that it was baked at 115 deg. C. for 35 min. A flawless coating was obtained.

(3) Blistering Caused by Hydrogen Occluded in Cavities

Commonly-used enamelling stock is so much

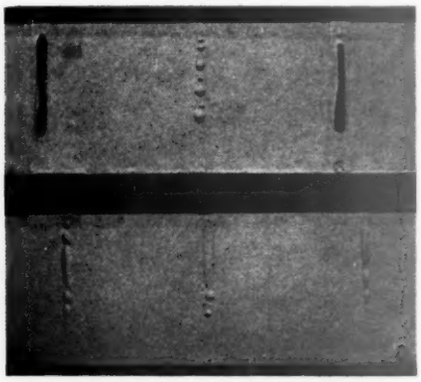


FIG. 20.—FRONT AND BACK VIEWS OF SPECIMEN (FIG. 18), FIRED 4 MIN. AT 810 DEG. C. WITH WHITE COVER COAT.

thinner than the plate used in this research that hydrogen dissolved in the steel is quite completely removed during the ordinary drying and baking periods. More elusive is the function of those portions of hydrogen that are withheld by cavities or by impurities in the steel. To identify separately the defects caused by hydrogen occluded at cavities or discontinuities within the steel, a plate similar to the previous specimen was drilled with three narrow holes as shown in Fig. 18. Small plugs were driven into the holes and the projecting ends were welded in with a torch. The wall thickness directly over the holes was $\frac{1}{32}$ in.

According to theories previously discussed, hydrogen absorbed by the steel during pickling will diffuse through the steel, and a portion of this hydrogen will precipitate in internal cavities because the partial pressure of atomic hydrogen in these cavities is zero. Molecular hydrogen will form immediately within the cavity, and because hydrogen dissolves only atomically, such trapped hydrogen will remain in the cavities until the steel is heated to a temperature at which the gas molecules freely dissociate in contact with steel. As enamel-firing temperatures are generally high enough to provide such dissociation, enamelling a specimen of the type shown in Fig. 18 should bring a train of defects, preferentially located directly over the cavities.

The specimen was therefore treated in the

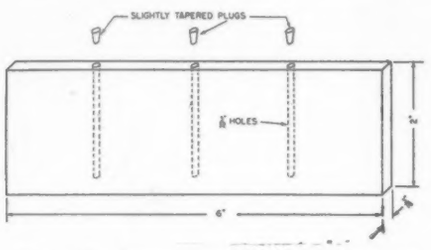


FIG. 18.—SKETCH SHOWING SPECIMEN OF $\frac{3}{16}$-IN. STEEL PLATE CONTAINING ARTIFICIAL GAS-TIGHT CAVITIES.

standard manner (pickling time, 25 min.) and was baked at 115 deg. C. for 1½ hrs. to ensure freedom from all dissolved hydrogen. Occluded hydrogen, of course, would remain in the steel. Fired with blue ground coat at 870 deg. C., the specimen is shown in Fig. 19.

Expectations were more than fulfilled, for the effusion of gas directly over the three cavities was so severe that the enamel in one instance was completely removed. A second firing showed no substantial decrease in the effusion, nor did a third firing.* The specimen was then sprayed with a white cover coat and fired four minutes at 810 deg. C. The result is shown in Fig. 20.

In spite of the fact that the specimen had been successively fired three times at 870 deg. C., a total time of 14 min. at that temperature, the gas continued to effuse so violently while firing the cover coat that blisters raised corresponding to the entire length of each cavity; and, as the specimen cooled, the hydrogen that had dissolved in the thin steel wall precipitated

FIG. 21.—TEST PLATE WITH HOLES UNSEALED, PURPOSELY OVERFIRED.

in such quantities that pressure developed, although counteracted by greatly decreased temperature, sufficient to explode several large blisters and to throw two of the largest several feet from the specimen. In the exposed areas under these two blisters, the ground coat is visible, and blisters in the ground coat in turn expose the steel. Note the marked difference in size of the blisters in ground and cover coats, as this difference explains many observations that have been made regarding the effect of enamel composition on the tendency to show these defects. Permeability and viscosity are obviously strong factors to consider in composing enamels that fire properly, but defects caused by hydrogen can only be mitigated, not corrected, by manipulation of the enamel composition.

To prove that the blistering in the present case was due to gas occluded in the cavities and not to overfiring caused by the rapid heating of the thin metal wall at these loci, two more identical plates were drilled in the same way, but the holes were left open so that hydrogen

FIG. 19.—FRONT AND BACK VIEWS OF ENAMELLED PLATE (FIG. 18) SHOWING SEVERE BLISTERING IN GROUND COAT.

could not be occluded. Both were fired with blue ground coat. One was then purposely overfired until burning occurred, but the burning bore no relation to the cavities, as may be seen in Fig. 21. The other plate was fired with white cover coat. The ground and cover coats on this specimen are shown in Fig. 22, and it is seen that there is no surface demarcation whatsoever to indicate where the holes lie.

To prove that the occluded gas responsible for the blistering under discussion was hydrogen and not merely air or other gases trapped during preparation of the cavities, an identical plate with sealed holes was cleaned by sand-

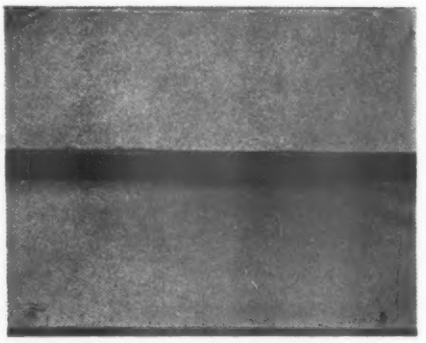


FIG. 22.—GROUND COAT (ABOVE) AND COVER COAT (BELOW) FIRED ON A PLATE CONTAINING OPEN HOLES.

blasting instead of by pickling. Fired with both blue ground and white cover coats, the specimen showed no defects whatsoever.

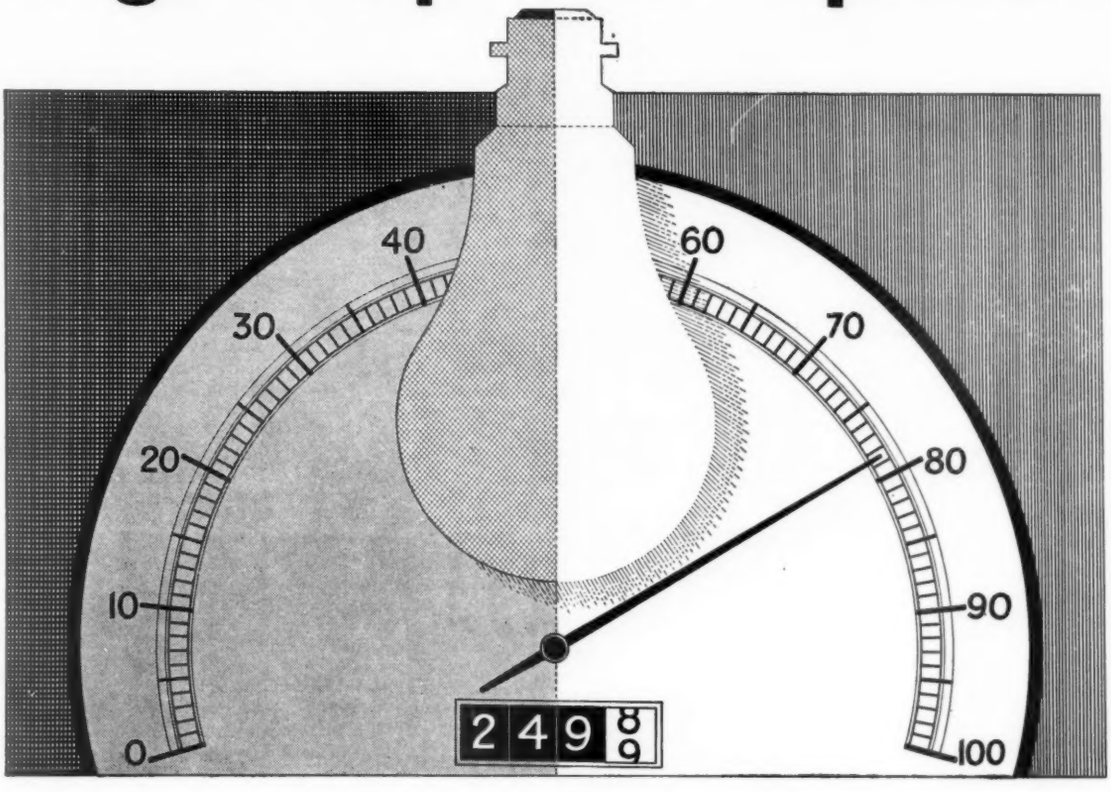
(To be continued.)

* It is hoped that the reader will appreciate that the specimens photographed in this research were prepared by metallurgists, not enamellers, and that numerous mechanical defacements have accordingly occurred that might have been avoided with better technique. Such mechanical defacements, however, are inconsequential to the thesis.

Rivets in Aircraft

According to an article in "Metal Progress" by WILLIAM B. STOUT, ordinary civil aircraft carries between 250,000 and 300,000 rivets, whilst the Strattoliner will include 700,000 at a cost of a half-penny each, excluding labour. The author recommends the use of welded stainless steel for aircraft.

Light up—for speed!



Faster yet! How? This way: when everything's planned to keep benches and tool shop properly fed, look to that vital speed-factor—light. The faster the operatives can see, the faster they work—and the lower the strain at the end of the shift. It pays, then, to fit Osram, the wonderful lamp—for reliable light, and your money's worth in light for every unit you burn. That's the way to speedier, livelier, war-winning output.

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The Week's News in Brief

Trade Talk

THE ANNUAL MEETING of the Industrial Welfare Society was held yesterday in London.

THE COMMONWEALTH GOVERNMENT has prohibited the export of scrap iron and steel from Australia to countries outside the British Empire.

MAJOR, ROBINSON & COMPANY, LIMITED, have removed from 385 and 387, City Road, Manchester, 15, to larger premises at "Scols" Works, 9, Eastnor Street, Manchester, 15.

JOHN A. SMEETON, LIMITED, have established a temporary office at 76, Auckland Road, London, S.E.19 (Telephone number, Livingstone 2925), to which address all future communications should be sent.

THE MINIMUM basis prices for the cheapest grades of borax and boric acid available, *i.e.*, commercial granulated, are now £26 and £42 10s. per ton respectively (1-ton lots, carriage paid within the U.K.).

EMPLOYEES of the North British Locomotive Company, Limited, Springburn, Glasgow, have forwarded a further sum of £250 from their Spitfire fund to the Minister of Aircraft Production. This is their third contribution, two donations of £250 each having been forwarded in October.

WILD-BARFIELD ELECTRIC FURNACES, LIMITED, of Watford, announce that in recent times they have dispatched various large types of electric furnaces to China, India, and Egypt, whilst they are regularly dispatching overseas the smaller types of soldering furnaces and the like.

A COMPANY with a capital of £500,000 has been formed in Tasmania to manufacture magnesium, which it is expected that the Federal Government will use for war purposes. The factory will be the third magnesium-producing plant in the Empire, the other two being in this country.

THE WROUGHT IRON ALLOYS DEVELOPMENT ASSOCIATION offers a research scholarship of £250 per annum, tenable for two years. Candidates should preferably be under 30 years of age. Particulars may be obtained from the Secretary of the Institution of Naval Architects, 10, Upper Belgrave Street, London, S.W.1.

PROVISION of canteens may now be made compulsory at any factory employing more than 250 persons, and which is engaged on Government work. The Order gives power to the Chief Inspector of Factories, or any other authorised Factory Inspector, to direct that a canteen shall be established and maintained. The canteen must be in or near the factory, and it may serve one or a group of factories. It must provide hot meals that can be bought by the persons employed.

A NEW SOVIET manganese-producing centre is being established in the North Urals. Preparations are said to be far advanced for the construction of a large enterprise early next year. The district in which the combine is planned to be built—near the village of Polunoch in the Ivdel Province—contains one of the largest manganese-ore deposits in the Soviet Union. The preliminary survey of the route for a new railway running from Ivdel to the manganese deposits has been completed.

GOLD WATCHES and long-service certificates were presented last week by G. & J. Weir, Limited, Holm Foundry, Cathcart, Glasgow, to Mr. Andrew Williams and Mr. Henry Dyer, who have completed 50 years' service in the works. In congratulating the recipients, Sir John R. Richmond said there were now nine members of the staff each with 50 years' service to their credit, and eight of them were present on that occasion. Sir John Richmond, who has himself completed 51½ years' service with the company, added that the combined service of the nine veterans was 462 years.

A GOVERNMENT STATEMENT issued last week gives notice that this year there will be no Bank Holiday on Boxing Day in England. Wales and Northern Ireland, or on Christmas Day in Scotland. To prevent any slackening in the flow of war production the Government appeal to all those engaged on war work to continue their efforts with not more than one day's holiday, to be taken either on Christmas Day or on New Year's Day. Industrial agreements relating to work on the cancelled Bank Holidays will not be affected by the Defence Regulation to be issued, and this means that the wages customary for work on these days will be paid.

Personal

MR. J. JOHNSON, secretary of Alfred Herbert, Limited, Coventry, has retired from the employ of the company after 43 years' service.

MR. WILLIAM LOMAS, chairman of J. & J. Dyson, Limited, Griffs Fireclay Works, Stannington, Sheffield, celebrated his 98th birthday on November 25.

DR. W. T. GRIFFITHS, manager of the Research and Development Department of the Mond Nickel Company, Limited, has been nominated Vice-President of the Institute of Metals.

MR. AND MRS. H. S. HARRIS have celebrated their golden wedding. For many years Mr. Harris was moulding-department foreman with John Pilling & Sons, Limited, Primet Foundry, Colne, in whose foundry he served for over half a century.

MR. A. H. MOORE, of the Standard Brass, Iron & Steel Foundries, Limited, of Benoni, and a well-known member of the Institute of British Foundrymen, has cabled £5,000 to the High Commissioner for South Africa in London for the purchase of a Spitfire, which he asked should bear the name of "Benoni."

MR. R. W. SKIPWITH has resigned from the board of the Zinc Corporation, Limited, and Mr. F. A. Crew has been appointed a director in his place. Mr. Crew was appointed secretary in January, 1915, and except for an interval during the last war, held the position until October, 1939, when he was appointed manager in London.

Obituary

MR. CECIL HERBERT ROBINSON, for a number of years a director of the North British Locomotive Company, Limited, Glasgow, has died.

MR. T. G. JACKSON, who was for the past three years cashier with the Lancashire Foundry Coke Company, Limited, Accrington, has died. He had been with the company for 18 years.

MR. EDWARD WILLIAM ANDERSON, A.M.I.C.E., M.I.Mech.E., who died recently at the age of 83, was the eldest son of the late Sir William Anderson, F.R.S., Director-General of Royal Ordnance Factories.

FORMERLY for 22 years manager, and for the past 13 years proprietor of the Vulcan Foundry, Dalston, Mr. Edwin Holt has died at the age of 74 years. In his younger days he had been a foundry manager in South America.

FLYING-OFFICER JAMES HAMMOND HOARE-SCOTT, whose death on service is announced, was a director of Scotts' Shipbuilding & Engineering Company, Limited, Greenock. He entered the firm in 1933. Flying-Officer Hoare-Scott was 29 years of age.

Reports and Dividends

Drake & Gorham, Limited—Dividend of 2 per cent.

Hepworth & Grandage, Limited—Dividend of 12½ per cent.

Garrard Engineering & Manufacturing Company, Limited—Interim dividend of 12½ per cent.

J. Brockhouse & Company, Limited—Final dividend of 12½ per cent., making 20 per cent. for the year ended September 30.

Marshall, Sons & Company (Successors), Limited—Final dividend of 10 per cent., making 13¾ per cent. for the year to September 30.

Whitehead Iron & Steel Company, Limited—Interim dividend on the ordinary stock of 10 per cent. on account of the year ending March 31 next.

Brown, Bayley's Steel Works, Limited—Final dividend of 10 per cent., tax free, on the ordinary shares, making 15 per cent., tax free, for the year ended July 31 last.

Contracts Open

Cairo, December 21—Iron and other metals, lead pipes, etc., for the Director-General, Tanzim Department, Ministry of Public Works. The Inspecting Engineer to the Egyptian Government, 41, Tothill Street, London, S.W.1.

Huddersfield, December 18—Cast-iron pipes, etc., for the year 1941, for the Waterworks Department. Mr. James P. Beveridge, waterworks manager, 24, Ramsden Street, Huddersfield.

Two Decades of Foundry Practice

(*Continued from page* 362.)

many castings which were made in steel are cast more economically in high-duty iron.

With intelligent cupola control, and the discovery of just what percentage of steel it is possible to utilise in the cupola, very high grade irons are possible. Irons with unusual corrosion resistance and resistance to wear are now available. It is difficult to forecast just what lies ahead in grey-iron manufacture, but if progress continues on the same scale as in the past 20 years, what will be attained is better left to the imagination. Even after the last war, cast iron was regarded as a cheap material suitable for use only where strength went with weight. Things have changed now, thanks to knowledge of the correct use of the many alloying metals and the refinement in melting control.

The apathy of foundrymen in not using every modern assistance in the elimination of scrap calls for severe criticism. Modern foundries cannot be run on old ideas.

In conclusion, the author would like to thank his colleagues of Rolls-Royce, Limited, for their assistance, especially Mr. Vickers and Mr. MacDougal, for their active co-operation.

New Companies

(From the Register compiled by Jordan & Sons, Limited, Company Registration Agents, 116 to 118, Chancery Lane, London, W.C.2.)

Grits, Limited, 47, Cowlishaw Road, Sheffield, 11—Capital, £1,000. Manufacturers of and dealers in abrasive materials, etc. Directors: G. Jowitt, G. Jowitt, jun., and H. Jowitt.

Frank Love, Limited, 45-47, Westminster Bridge Road, London, S.E.1—Capital, £30,000. Manufacturers and dealers in iron, steel, copper, brass goods, etc. Directors: F. Love, J. G. Mann and G. Tysoe.

Forthcoming Events

DECEMBER 14.

Manchester Association of Engineers:—Quarterly meeting. "Some Experiences in Organising the Design and Manufacture of Small Engineering Apparatus," Paper by G. A. Cheetham, at Manchester, at 2.30 p.m.

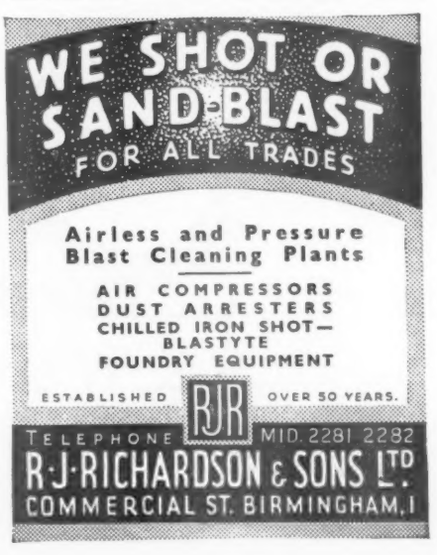
Institute of British Foundrymen

DECEMBER 14.

East Midlands Branch:—"Developments in Foundry Refractories," Paper by E. J. Crawley, at Derby.

Scottish Branch:—"Observations on Contraction in Cast Iron," Paper by E. Longden, at Glasgow, at 3 p.m.

West Riding of Yorkshire Branch:—Discussion on Report of Melting Furnaces Sub-Committee of the Institute's Technical Committee, "Melting Furnaces for Grey Cast Iron," opened by F. K. Neath, at Bradford, at 6.30 p.m.



Acknowledgments to Manganese Bronze and Brass Co. Ltd., Woodall-Duckham Co. (1920) Ltd., and Hadfields Ltd.

The modern development of refractory materials owes much to close co-operation between manufacturer and user of refractories. As Britain's leading manufacturers, General Refractories enjoy the custom and confidence of many thousands of refractories users engaged in every branch of the metallurgical, engineering and other industries of the world. This intimate relationship is fostered by General Refractories because it provides "G.R." engineers and chemists with a real close-up picture of the actual needs of every type of user. In addition, it provides an invaluable fund of practical experience—which proves the soundest basis on which to maintain and develop a high standard of consistently uniform quality products. This method of procedure is your assurance that there is not only a "G.R." product made for your particular business—but that if you have a problem involving refractories, "G.R." data and experience will help you to find the answer. We want you to feel free to consult the "G.R." Technical Advisory Section at all times. It will enable you to tap this vast organisation for the greater efficiency of your business or plant.

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G.P.S.

FIREBRICKS: *Glenboig Special, Glenboig Special Crown, Glenboig, Glenboig Crown, Castlecary, Dykehead, Gem, White Carr, Stour, Hycone, Alumantine, Hysilyn, Adamantine, Llangennech.*
BASIC BRICKS: *Spinella, Saxpyre, Supermag, Diazite, Dolomax.*
ACID-PROOF REFRACTORIES: *Obsidianite, Losol.*

INSULATION: *Amberlite* Bricks, Cement and Concrete.
SILICA BRICKS: *Lowood, Meltham, Allen, Quartex.*
CEMENTS: *Sintex, Durax, Pyrolyte.* PLASTICS: *Durax, Rotaline, Plastic K-N., Glendoline, Ground Ganister.*
SILLIMANITE: Tank Blocks, Bricks and Cements.
SANDS: Moulding, Brick Facing, Silica, Glass.

Raw Material Markets

Iron and steel makers continue to be fully booked up to the end of the year, and in the case of some pig-iron producers, orders have been accepted for January delivery. In any case, the position at many producing plants indicates that they will have to carry over deliveries scheduled for the last quarter of this year. Government contracts are quite sufficient to keep heavy engineering concerns fully employed, although at times they have accepted other work of an important character. The situtation among light-castings foundries is steadily improving, but this section still requires a greater volume of business. High hopes are placed on prospects of additional Government work becoming available for this trade, but at present this is materialising at rather a slow pace, although quite a considerable amount of official work in the aggregate has been handed out of late.

Pig-Iron

MIDDLESBROUGH—With almost all local blast furnaces engaged on the production of iron for the steelworks, the output of Cleveland foundry numbers is negligible, and users are drawing on Derbyshire and Northants makers for their supplies. Fortunately, despite the very substantial call on these sources of supply, deliveries are coming to hand satisfactorily. At times there is delay in obtaining supplies, not due in any way to shortage, but largely to hold-ups in transport. Light-castings foundrymen here are now much better placed, although many of them would welcome still further business. There is no idle time among heavy engineering establishments, which are operating their plants to capacity on work of national importance. Increasing use of cast-iron scrap, which is available in ample tonnages, is being made at foundries.

It has been necessary to augment home production of hematite with supplies of foreign material, large ship loads of which have arrived at United Kingdom ports. It is understood that further consignments will be imported during the next few months, and, meanwhile, every effort is being made to expand home outputs.

LANCASHIRE—Common grades of foundry pig-iron are in brisk request in this area, especially from those concerns occupied with requirements of the various Government departments, and the demand has reached a very high level. Deliveries of Midlands iron, on the whole, fully meet all needs, but it is noticeable that there is some delay from time to time in recovering supplies, owing to difficulties in connection with railway working. It cannot be said, however, that important work has been inconvenienced on this account. Certain jobbing foundries have recently experienced a falling off in specifications, while makers of light castings continue to seek additional orders; the volume of Government work placed with this trade has not been enough to counteract the loss of outlets for its products brought about by wartime conditions. West Coast hematite and other special irons remain in rather short supply, preference in allocations, of course, being given to priority users.

MIDLANDS—The demand for high-phosphorus iron continues to grow, but makers are giving satisfactory deliveries to users and there is every reason to expect a continuance of these happy conditions. New outlets have lately materialised for light castings, and makers are now doing a much improved turnover. Government calls have increased, while a small tonnage is being exported and the needs of the building trade have tended to be on an enlarged scale, so that the position of the industry is better than at any time since the outbreak of hostilities. Nevertheless, there is still room for improvement, as the light-castings section has been badly hit by wartime restrictions. Appreciable tonnages of low-phosphorus iron, hematite and refined irons have been bought from abroad under the authority of the Iron and Steel Control. This was necessitated by home production being unable to cope with the substantial pressure for supplies from heavy engineers and other works which are playing a big part in the defence programme. Supplies are being allotted first to these concerns, but some iron has been made available for other consumers in possession of important contracts involving the use of these grades.

SCOTLAND—Current needs of heavy engineers are being met, but no allowance can be made for the laying in of a reserve stock. Licences are being granted freely to priority consumers, but scant attention can be paid in the circumstances to other applications. Trade in the Falkirk area, where are situated most of the light-castings makers, is better, although few works can as yet report full-time operations. Basic and hematite are in heavy demand by local steelworks.

Coke

Inland demand for foundry coke is well maintained, but many ovens have been handicapped by the loss of export markets. Home consumers have pursued earnestly a policy of stocking during the summer and are now in the happy position of having substantial tonnages at their disposal. Even so, founders continue to purchase their immediate requirements and large deliveries are being called for. New prices for Durham coke were finally agreed upon at a meeting last week, quotations f.o.t. ovens now being 35s. 6d. for furnace coke and 42s. for foundry grade, f.o.t. ovens. Delivered prices vary, of course, according to the railway haul; for Middlesbrough they are: Furnace coke, 39s. 6d.; foundry coke, 46s. For delivery to Birmingham and Black Country stations, the price of Durham best foundry coke is 58s. per ton.

Steel

Steel consumers are awaiting the issue of purchasing licences for the first quarter of the new year, and they will lose no time in placing orders when the allocations have been made. There is still much material to be delivered on account of business for the current period, and it is obvious that some deliveries will have to be carried over into the January-March quarter. Pressure for supplies is maintained in practically all sections of the trade, priority users being the main buyers. Owing to the large requirements of the firms engaged on urgent Government work, little can be spared for other needs, although licences are granted on occasions for civil contracts of an important nature. Home production of steel is on a very satisfactory scale, but is, nevertheless, unable to meet the abnormal demands, so that fair tonnages of foreign material are having to be brought into the country.

Scrap

Scrap iron and steel of most descriptions is now available freely, and is, in fact, being used on a larger scale, as consumers of foundry iron are able to make use of scrap quite extensively as a substitute. In this way, the demand for common iron has been reduced. Scrap users generally have good tonnages stocked at their plants, while dumps have been built up at various points convenient for distribution purposes. The collection of further supplies is not, of course, being neglected and heavy tonnages are coming forward regularly.

Metals

The London tin market has again been rather uninteresting, with price movements within narrow limits. As yet, the completion of negotiations with Bolivian ore producers in connection with the plan for the establishment of a smelter has had little, if any, effect on the United States market, as it is realised that it will be a considerable time before the metal resulting will be available for the market. It is believed that the authorities will accumulate from 15,000 to 20,000 tons of Bolivian concentrates in preparation for the smelting operations. Tinplate operations in America continue to be at around 45 per cent., and not much improvement can be expected before the end of the year. Buyers in this section of the trade are not likely to do more buying of tin than the replacements required from time to time to keep their stocks up to levels already decided upon as ample to carry through almost any emergency.

According to the Statistical Bulletin of the Tin Research Institute, controlled by the International Tin Research and Development Council, world production of tin in October is estimated at 19,900 tons, compared with 23,200 tons in September. The total production for the first ten months of the year is approximately 193,500 tons, against 136,800 tons in the corresponding period of 1939. United States deliveries totalled 93,634 tons in the first ten months of 1940, showing an increase of more than 77 per cent. as compared with the deliveries of 52,660 tons in the first ten months of 1939. This year's deliveries include tin acquired for the emergency reserve stock. Consumption of tin in the United Kingdom in the first nine months of 1940 was 22,601 tons, against 18,352 tons in the corresponding period of 1939. World stocks of tin, including smelters' stocks and carry-over, increased by 1,066 tons during October to 53,890 tons at the end of the month. Stocks at the end of October, 1939, were 46,561 tons.

According to C. S. Trench & Company, Inc., of New York, estimated consumption of tin is at the following levels:—United States and Canada, 80,000 tons; United Kingdom, 30,000; Continent, 10,000; Russia, 15,000; Japan, 10,000; other countries, 10,000 tons, making a total of 155,000 tons. The same firm indicates that production, calculated on the basis of 130 per cent. quotas, is at the rate of 255,000 tons, or 100,000 tons ahead of actual consumption (8,000 tons per month). Messrs. Trench estimate that of the 93,634 tons of tin delivered in the United States since the beginning of the year, 30,000 to 33,000 tons represented stock accumulation by consumers or for Government account, of which some 15,000 tons went into the stock piles during the past three months. Even more rapid accumulation is now expected.

Referring to the Excess Profits Tax, in relation to the tin-mining industry, at the meeting of Kamunting Tin Dredging, Limited, on Friday Sir Archibald Mitchelson, chairman, said that during the standard year for E.P.T. the production of tin was restricted. Now, under war conditions, in order to meet the abnormal requirements the companies were urged to produce up to the maximum possible and with E.P.T. at 100 per cent. on any excess over the profit standard producers were faced with the serious problem of accelerating the wastage of their capital assets and thus unduly shortening the life of the mines, without any compensation for the additional tonnage produced. Every ton of metal produced, being irreplacable, represented a part of the capital assets, reduced the naturally short life of the mines and was therefore tantamount to a capital levy. This vital matter was being taken up with the Treasury on behalf of the tin industry as a whole, with a view to finding a remedy for this obviously unfair incidence of E.P.T., which, if continued, was bound to have disastrous effects on the Empire tin-mining industry. It was strongly felt that the Chancellor could never have anticipated, or had in contemplation, such a result.

London Metal Exchange tin prices this week have been as follow:—

Cash—Thursday, £258 to £258 5s.; Friday, £258 to £258 5s.; Monday, £257 15s. to £258; Tuesday, £257 10s. to £257 15s.; Wednesday, £257 10s. to £258.

Three Months—Thursday, £260 to £260 5s.; Friday, £260 10s. to £260 15s.; Monday, £260 to £260 5s.; Tuesday, £260 to £260 5s.; Wednesday, £260 to £260 10s.

Supplies of copper for other than essential needs continue to be restricted. The war effort involves substantial tonnages of the red metal, but no priority user is unable to acquire his full supply. Empire producers are despatching copper as freely as is desirable, but so long as urgent needs are met, the Government is reluctant to use additional shipping space for imports of the metal. Consumption in the United States is expanding, although the market is rather featureless. It is believed that American consumption of copper in 1941 will far outstrip her production, by as much as 120,000 tons, it is suggested in some quarters.

Spelter continues to be absorbed by the British war machine on a large scale, but urgent needs are being met satisfactorily. The Canadian Metals Controller has announced that no further exports of zinc, dross, remelted zinc in slabs, or high-grade zinc scrap will be permitted.

The lead supply position is easy and quite heavy tonnages are being released for non-essential uses.

ALUMINIUM ALLOYS
and the Foundryman

The swift march of engineering progress demands an ever increasing degree of efficiency in foundry production . . . That is why more and more foundrymen rely upon International Alloys Ltd. as their best source of supply for all Aluminium Alloys. They know that the metals produced by this organisation consistently conform to specification.

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RAW MATERIALS—PRICE LIST

Wednesday, December 4, 1940

COPPER*

	£	s.	d.
Electrolytic	62	0	0
High-grade fire-refined	61	10	0
Fire-refined of not less than 99.7 per cent.	61	0	0
Do., do., 99.2 per cent.	60	10	0
Black hot-rolled wire rods	65	10	0

TIN

	£	s.	d.
Standard cash	257	10	0
Three months	260	0	0
Settlement	257	10	0
Official average Cash, Nov.	258	7	6
Do. Three Months, Nov.	260	5	1½
Do. Settlement, Nov.	258	6	5½

SPELTER*

	£	s.	d.
G.O.B. (foreign) (duty paid)	25	15	0
Do. (domestic)	26	10	0
"Prime Western"	26	10	0
Refined and electrolytic	27	5	0
Not less than 99.99 per cent.	28	15	0

LEAD*

	£	s.	d.
Good soft pig lead (foreign) (duty paid)	25	0	0
Do., do., (Empire and domestic)	25	0	0
English	26	10	0
Sheets, home	34	10	0
Do. export, f.o.b.	30	0	0
Pipes, home	34	0	0
Do. export, f.o.b.	30	10	0
Tea lead (nom.)		—	

ALUMINIUM

Ingots	£110
Wire, 10g.	nom.
Sheets	nom.
Circles, 20/24g.	nom.

ZINC SHEETS, etc.

	£	s.	d.
Sheets, 10g. and thicker, ex works	39	2	6
Rolled zinc (boiler plates), ex works	37	2	6
Zinc oxide (Red Seal), d/d buyers' premises	28	7	6

ANTIMONY

English, 90%, delivered	90 0 0
Foreign Regulus, duty paid	90 0 0 to 93 0 0
Chinese, prompt shipment, c.i.f.	78 0 0 to 82 0 0

QUICKSILVER

Quicksilver, ex-w'hse London 48 0 0 to 51 0 0

HIGH-SPEED TOOL STEEL

Finished bars, 14% tungsten	3s. 0d.
Finished bars, 18% tungsten	3s. 10d.
Finished bars, 22% tungsten	4s. 4d.

Per lb. d/d buyers' works.

NICKEL SILVER, etc.

	Per lb.
Ingots for raising	9d. to 1/3
Rolled—	
To 9 in. wide	1/3 to 1/9
To 12 in. wide	1/3½ to 1/9½
To 15 in. wide	1/3½ to 1/9½
To 18 in. wide	1/4 to 1/10
To 21 in. wide	1/4½ to 1/10½
To 25 in. wide	1/5 to 1/11
Ingots for spoons and forks	9d. to 1/5½
Ingots rolled to spoon size	1/- to 1/8½
Wire round—	
to 10g.	1/6½ to 2/1½

with extras according to gauge.

Special 5ths quality turning rods in straight lengths, 1/5½ upwards.

* Maximum prices per long ton delivered to buyers' premises.

FERRO-ALLOYS AND STEEL-MAKING METALS

(all prices nominal.)

	£	s.	d.
Ferro-silicon (5-ton lots)—			
25%	18	10	0
45%	23	10	0
75%	36	10	0
Ferro-vanadium—			
35/50%	15/6 lb. Va.		
Ferro-molybdenum—			
70/75% carbon-free	6/- lb. Mo.		
Ferro-titanium—			
20/25% carbon-free	1/9 lb.		
Ferro-tungsten—			
80/85%	5/1 lb.		
Tungsten metal powder—			
98/99%	5/2½ lb.		
Ferro-chrome—			
2/4% car.	—		
4/6% car.	47	0	0
6/8% car.	47	0	0
8/10% car.	—		
Ferro-chrome—			
Max. 2% car.	—		
Max. 1% car.	—		
Max. 0.5% car.	—		
70% carbon-free	—		
Nickel—99.5/100%	£190 to £195		
"F" nickel shot	175	0	0
Ferro-cobalt, 98/99%	8/9 lb.		
Metallic chromium—			
96/98%	3/9 lb.		
Ferro-manganese—			
76/80% loose	18	10	0
76/80% packed	20	0	0
Metallic manganese—			
94/96% carbon-free	1/9 lb.		

Per ton unless otherwise stated, basis 2-ton lots, d/d Sheffield works.

SCRAP*

	£	s.	d.	£	s.	d.
SOUTH WALES—						
Short heavy steel, not ex. 24-in. lengths	3	16	6	to 3	19	0
Heavy machinery cast iron			4	6	6	
Ordinary heavy cast iron			4	1	6	
Cast-iron railway chairs			4	6	6	
Medium cast iron			3	17	9	
Light cast iron			3	13	0	
MIDDLESBROUGH—						
Short heavy steel	3	14	3	to 3	16	9
Heavy machinery cast iron			4	11	3	
Ordinary heavy cast iron			4	8	9	
Cast-iron railway chairs			4	8	9	
Medium cast iron			3	19	0	
Light cast iron			3	14	0	
BIRMINGHAM DISTRICT—						
Short heavy steel	3	9	3	to 3	11	9
Hematite ingot mould			5	10	9	
Heavy machinery cast iron			4	11	9	
Ordinary heavy cast iron			4	7	0	
Cast-iron railway chairs			4	7	0	
Medium cast iron			3	19	9	
Light cast iron			3	14	9	
SCOTLAND—						
Short heavy steel	3	14	0	to 3	16	6
Heavy machinery cast iron			4	13	9	
Ordinary heavy cast iron			4	8	9	
Cast-iron railway chairs			4	13	9	
Medium cast iron			3	16	9	
Light cast iron			3	11	9	

* Delivered free to consumers' works in England and Wales. For deliveries of cast-iron scrap free to consumers' works in Scotland, the above prices less 3s. per ton, but plus actual cost of transport or 6s. per ton, whichever is the less. All prices: Plus 2½ per cent. dealers' remuneration: 50 tons and upwards over three months 2s. 6d. extra.

PIG-IRON*

N.E. COAST (d/d Tees-side area)—	
Foundry No. 1	131/-
„ No. 3	128/-
„ No. 4	127/-
Forge No. 4	127/-
Hematite No. 1	138/6
Hematite M/Nos.	138/-
N.W. COAST—	
Hem. M/Nos. d/d Glasgow	138/6
„ d/d Birmingham	150/-
MIDLANDS (d/d Birmingham dist.)—	
Staffs No. 4 forge	129/-
„ No. 3 fdry.	130/-
Northants forge	126/6
„ fdry. No. 3	127/6
„ fdry. No. 1	130/6
Derbyshire forge	129/-
„ fdry. No. 3	130/-
„ fdry. No. 1	133/-
Phosphorus 0.5% to 0.75%	137/6
Phosphorus 0.1% to 0.5%	140/6
SCOTLAND—	
Foundry No. 1, Grangemouth	127/3
„ No. 3, Grangemouth	124/9
Cleveland No. 3, Glasgow	131/-
„ „ Falkirk	128/-
Scottish hem. M/Nos. d/d	138/6
SHEFFIELD (d/d district)—	
Derby forge	126/6
„ fdry. No. 3	127/6
Lincs forge	126/6
„ fdry. No. 3	127/6
W.C. hematite	144/-
LANCASHIRE (d/d eq. Man.)—	
Derby fdry. No. 3	133/-
Staffs fdry. No. 3	133/-
Northants fdry. No. 3	131/6
Cleveland fdry. No. 3	133/-
Cylinder and Refined Irons	
North Zone	174/-
South Zone	176/6
Refined Malleable	
Birmingham and S. Staffs	171/6
Cold Blast	
South Staffs	220/6

* Prices of hematite and basic pig-iron, and of foundry and forge iron with a phosphoric content of not less than 0.75 per cent., are subject to a rebate of 5s. per ton under certain conditions.

SEMI-FINISHED STEEL

Re-rolling Billets, Blooms and Slabs.

	£	s.	d.
BASIC:			
Soft, u.t., 100-ton lots	12	5	0
Tested, up to 0.25% C.	12	10	0
Tested, 0.25 to 0.33% C.	12	12	6
Tested, 0.33 to 0.41% C.	12	15	0
Hard (0.42 to 0.60% C.)	13	17	6
„ (0.61 to 0.85% C.)	14	7	6
„ (0.86 to 0.99% C.)	14	17	6
„ (1% C. and up)	15	7	6
Silico-manganese	16	5	0
Free-cutting	14	10	0
SIEMENS MARTIN ACID			
Up to 0.25% C.	15	15	0
Case-hardening	16	12	6
Silico-manganese	16	5	0

Billets, Blooms and Slabs for Forging and Stamping.

Basic soft, up to 0.25% C.	13	17	6
Basic hard, 0.41 to 0.60% C.	14	10	0
Acid, up to 0.25% C.	16	5	0

Other Semi-products, etc.

Tin bars	12	2	6
Sheet bars	12	2	6
*Wire rods, soft basic	17	7	6
„ hard basic	21	2	6
„ free-cutting	20	2	6
„ acid	24	13	

* Subject to rebate

FINISHED STEEL

Usual district deliveries

[A rebate of 15/- per ton for steel bars, sections, plates, joists and hoops is obtainable in the home trade under certain conditions.]

	£	s.	d.
Plates, ship (N.E. Coast)	16	3	0
Boiler plts. (N.E. Coast)	17	0	6
Chequer plts. (N.E. Coast)	17	13	0
Angles, over 4 un. ins.	15	8	0
Tees, over 4 un. ins.	16	8	0
Joists, 3 in. × 3 in. and up	15	8	0
Rounds and squares, 3 in. to 5½ in.	16	8	0
Rounds under 3 in. to ½ in. (untested)	17	12	0
Flats—over 5 in. wide	15	13	0
„ 5 in. wide and under	17	12	0
Rails, heavy, f.o.t.	14	10	6
Hoops	18	7	0
Black sheets, 24 g. (4 t. lots)	22	15	0
Galv. cor. shts. („)	26	2	6
Galv. flat shts. („)	26	12	6
Galv. fencing wire, 8g. plain	26	17	6

FINISHED IRON

	£	s.	d.
CROWN IRON:			
England and Wales	15	12	6
Scotland	15	12	6
Ireland, f.o.q.	16	5	0
No. 3 BARS:			
England and Wales	12	10	0
Scotland	13	12	6
Ireland, f.o.q.	13	2	6
No. 4 BARS:			
England and Wales	13	0	0
Scotland	13	17	6
Ireland, f.o.q.	13	12	6
STRIP:			
England and Wales	17	0	0
STAFFS MARKED BARS, f.o.t.	—		

AMERICAN IRON AND STEEL

At Pittsburgh unless otherwise stated, November 14, 1940.

	Dols.
No. 2 foundry, Phila.	24.84
No. 2 foundry, Valley	23.00
No. 2 foundry, Birm.	19.38
Basic, Valley	22.50
Malleable, Valley	23.00
Grey forge, Valley	22.50
Ferro-mang., seaboard	120.00
O.-h. rails, h'y, at mill	40.00
Billets	34.00
Sheet bars	34.00
	Cents
Iron bars, Chicago	2.25
Steel bars	2.15
Tank plates	2.10
Beams, etc.	2.10
Wire rods	2.00
Skelp, grooved steel	1.90
Steel strip	2.10
Steel sheets	2.10
Sheets, galv., 24 g.	3.50
Wire nails	2.55
Plain wire	2.60
Tinplates, 100-lb. box	$5.00

COKE (at ovens)

(nominal)

Welsh foundry	46/6 to 48/-
„ furnace	35/6 to 37/-
Durham foundry	42/-
„ furnace	35/6
Scottish foundry	45/- to 50/-
„ furnace	33/6 to 35/6

TINPLATES

(f.o.b Bristol Channel ports)

I.C. cokes	20 × 14 per box		30/9 to 32/-
„	28 × 20	„	61/6 to 64/-
„	20 × 10	„	44/3 to 44/9
„	18¾ × 14	„	32/- to 32/6
C.W.	20 × 14	„	27/9 to 28/9
„	28 × 20	„	55/6 to 57/6
„	20 × 10	„	42/3 to 42/9
„	18¾ × 14	„	30/- to 30/6

NON-FERROUS SCRAP

(Official Maximum Prices, per ton ex Works.)

	£	s.	d.
Bright untinned copper wire, in crucible form or in hanks	57	10	0
No. 1 copper wire	57	0	0
No. 2 copper wire	55	10	0
Copper firebox plates, cut up	57	10	0
Clear untinned copper, cut up	56	10	0
Braziery copper	53	10	0
Q.F. process and shell-case brass, 70/30 quality, free from primers	49	0	0
Clean fired 303 S.A. cartridge cases	47	0	0
70/30 turnings, clean and baled	43	0	0
Brass swarf, clean, free from iron and commercially dry	34	10	0
New brass rod ends, 60/40 quality	38	10	0
Hot stampings and fuse metal, 60/40 quality	38	10	0
Admiralty gunmetal, 88-10-2, containing not more than ¼ per cent. lead or 3 per cent. zinc, or less than 9½ per cent. tin	72	0	0

NEW BRASS TUBES, etc.

	Per lb.
Solid drawn tubes	13¼d.
Brazed tubes	15¼d.
Rods, drawn	11¼d.
Rods, extd. or rlld.	8¼d.
Sheets to 10 w.g.	10¼d.
Wire	10¼d.
Rolled metal	9¼d.
Yellow metal rods	8¼d.

COPPER TUBES, etc.

Solid drawn tubes	14¼d.
Brazed tubes	14¼d.
Wire	9¼d.

PHOSPHOR BRONZE

	Per lb. basis
Strip	13¼d.
Sheet to 10 w.g.	13¼d.
Wire	15¼d.
Rods	15¼d.
Tubes	20¼d.
Castings	17d.

Delivery 3 cwt. free.

10% phos. cop. £35 above B.S.
15% phos. cop. £40 above B.S.
Phosphor tin (5%) £40 above price of English ingots.

C. CLIFFORD & SON, LIMITED.

AVERAGE MONTHLY PRICES OF FURNACE COKE D/D MIDDLESBROUGH

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Yearly average.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1908	0 16 0	0 16 0	0 15 6	0 16 0	0 16 3	0 16 0	0 15 6	0 15 6	0 15 6	0 15 3	0 16 0	0 16 0	0 15 9¾
1909	0 16 0	0 15 3	0 15 0	0 14 9	0 15 6	0 15 9	0 15 6	0 15 6	0 16 6	0 17 0	0 17 6	0 17 0	0 15 11¼
1910	0 18 4½	0 18 6¾	0 18 0	0 18 0	0 17 10½	0 17 0	0 16 1½	0 15 9½	0 15 11	0 16 0	0 15 9½	0 15 8	0 16 11
1911	0 16 0	0 15 10½	0 15 6	0 15 3	0 14 9	0 14 6	0 14 6	0 14 6	0 14 6	0 14 11½	0 15 0¾	0 16 3¼	0 15 1¼
1912	0 17 3	0 17 3	0 18 6	0 18 10	0 19 0	0 19 4½	0 19 10½	1 0 9½	1 2 9	1 4 1½	1 5 8¾	1 8 6	1 1 0
1913	1 5 9	1 4 11	1 5 0	1 5 0	1 4 9½	1 0 4½	0 19 5½	0 18 3	0 8 0	0 18 2½	0 18 6	0 18 6	1 1 4¼
1914	0 18 2	0 17 1	0 17 0	0 17 0	0 17 4	0 17 6	0 17 6	0 18 5	0 8 4	0 17 9	0 17 6	0 18 5	0 17 8
1915	0 17 10½	0 17 9	1 0 4½	1 7 7½	1 9 4½	1 10 7½	1 9 7	1 7 3	1 5 4	1 4 9	1 9 6	1 13 0	1 6 1
1916	1 10 9	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6¼
1917	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 14 3	1 15 6	1 11 2¾
1918	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6
1919	1 15 6	1 15 6	1 15 6	1 15 6	2 1 6	2 1 6	2 3 9	2 10 6	2 10 6	2 10 6	2 10 6	2 10 6	2 3 5
1920	2 12 3	2 14 0	2 19 0	2 19 0	3 3 8	3 6 0	3 6 0	3 6 0	3 6 0	3 6 0	3 6 0	3 6 0	3 2 6
1921	3 1 0¾	2 19 0	2 16 0	2 7 0	2 6 6	2 6 6	2 0 6	2 0 0	1 13 11	1 12 9	1 10 4½	1 8 3	2 3 6½
1922	1 7 0¾	1 8 1½	1 9 7½	1 8 4½	1 7 11½	1 7 3	1 6 9¾	1 6 10½	1 7 0¾	1 10 2½	1 10 0	1 9 11½	1 8 3½
1923	1 11 3	1 14 6	2 0 1½	2 2 8½	2 4 4½	2 2 10¾	2 1 0¾	2 1 6	2 0 9¾	1 18 9	1 18 8½	1 18 3	1 19 7½
1924	1 16 6¾	1 14 9	1 11 11½	1 10 0¾	1 8 1¾	1 7 8½	1 7 3	1 6 3	1 6 0	1 5 0	1 5 0	1 5 0	1 9 5½
1925	1 4 10½	1 4 1½	1 13 3	1 2 4½	1 2 2½	1 1 5½	1 1 3½	1 4 9	0 18 10½	0 18 4½	0 19 6¾	1 1 4½	1 2 8¾
1926	1 2 1½	1 0 9	0 19 2½	0 18 6¾	*	*	*	*	*	*	*	1 5 0	1 1 1½‖
1927	1 5 6	1 4 9¾	1 6 1½	1 3 9	1 2 6	1 0 8½	0 19 4½	0 19 0	0 18 7½	0 18 0	0 17 10½	0 17 6	1 1 1¼
1928	0 17 6	0 17 10¾	0 18 0¾	0 17 11½	0 17 8½	0 17 6¾	0 17 7½	0 17 6¾	0 17 6	0 17 7½	0 17 7	0 17 6	0 17 8
1929	0 17 7¾	0 18 0	0 19 0	0 19 6¾	0 18 10½	0 19 10½	1 1 3¾	1 1 8½	1 3 0	1 3 6	1 3 8	1 3 1½	1 0 9¾
1930	1 2 6½	1 1 3	1 0 3	0 19 1½	0 17 7	0 16 10½	0 16 6	0 16 9	0 16 9	0 17 0	0 17 0	0 17 0	0 18 2½
1931	0 17 0	0 16 7½	0 16 0	0 16 0	0 15 11	0 15 5	0 15 1	0 15 0	0 15 0	0 16 9	0 17 0	0 16 6	0 16 0½
1932	0 17 0	0 16 11½	0 16 5½	0 15 9	0 15 7½	0 15 6	0 15 6	0 14 9¾	0 14 6½	0 14 6	0 14 6	0 15 4	0 15 6½
1933	0 16 0¾	0 15 11½	0 15 6½	0 15 6	0 15 6	0 15 6	0 15 6	0 15 8¾	0 16 1½	0 17 0	0 17 6	0 18 0	0 16 1½
1934	0 19 4½	1 0 6	1 0 1½	1 0 0	1 0 0	1 0 0	1 0 0	1 0 0	1 0 0	1 0 0	1 0 0	1 0 0	1 0 0
1935	1 0 0	0 19 6¾	0 19 0¾	0 19 0	0 19 0	0 19 0	0 19 0	0 19 0	0 18 9¾	0 18 9½	0 19 5½	1 1 2½	0 19 3¾
1936	1 2 0	1 2 11½	1 3 2½	1 4 0	1 4 11½	1 5 3¾	1 5 1½	1 4 7½	1 4 6	1 4 6	1 4 6	1 4 6	1 4 1¼
1937	1 5 6	1 5 10½	1 7 7½	1 12 9½	1 15 0	1 19 3¾	1 18 6½	2 0 0	2 0 3½	2 1 10½	2 2 0	2 2 0	1 16 1¼
1938	2 0 1½	1 16 7½	1 16 6	1 16 6	1 16 6	1 13 9¾	1 11 11½	1 11 6	1 11 6	1 11 6	1 11 6	1 11 6	1 13 9
1939	1 8 0	1 8 0	1 8 0	1 8 0	1 8 0	1 8 0	1 8 0	1 8 0	1 8 0	1 8 0	1 13 0	1 13 0	1 8 10
1940	1 13 0	1 14 10½	1 15 6	1 15 6	1 15 6	1 15 8	1 16 11¾	1 17 5	1 17 5	1 17 5	1 19 9½	—	—

* Strike period. ‖ Five months.

WILLIAM JACKS & COMPANY LIMITED
WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

CLARENCE CHAMBERS, 39, CORPORATION STREET, BIRMINGHAM.
13, RUMFORD STREET, LIVERPOOL.

PIG IRON

All grades FOUNDRY, HEMATITE, BASIC, SPECIALS, &c.

NON-FERROUS METALS

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM JACKS & COMPANY LIMITED
CENTRAL CHAMBERS, 93, HOPE ST., GLASGOW, C.2
ZETLAND ROAD, MIDDLESBROUGH.

Notice

Small Advertisements in this section of the Journal are accepted at the prepaid rate of 6d. per line, first line in capitals counting two, average 6 words per line Minimum charge for one insertion 3/-

(A remittance should accompany instructions.)

SITUATIONS VACANT AND WANTED

TO ENGINEERS AND IRONFOUNDERS.—Expert advice given to ironfounders who are in difficulties owing to shortage of low-phosphorus pig-irons. 30 years' experience in the mixing of irons. Analyses and mechanical tests accurately undertaken.—Apply to A. R. SCOTT, Metallurgist, New Whittington, Chesterfield.

FOUNDRY MANAGER required for large Sand Foundry engaged on Aluminium Alloys. State age, experience and salary required. Applications will be regarded as confidential.—GENERAL MANAGER, WILLIAM MILLS, LTD., Grove Street, Birmingham, 18.

WANTED by general engineering firm in Eastern county, Assistant Foundry Foreman, experienced in production of good-class iron castings in green and dry sand, by Sand Slingers and Jolt Ramming machines. Candidates must possess sound knowledge of cupola practice and have experience in oil sand cores.—Apply, Box 574, Offices of THE FOUNDRY TRADE JOURNAL, 3, Amersham Road, High Wycombe.

WANTED by large Grey Iron Foundry in Midlands, Chemist, with experience in control of Moulding Sand and Core Sand Mixtures. Splendid opportunity for the right man.—Box 578, Offices of THE FOUNDRY TRADE JOURNAL, 3, Amersham Road, High Wycombe.

EMPLOYMENT REGISTER.

Correspondence should be addressed to the General Secretary, Institute of British Foundrymen, St. John Street Chambers, Deansgate, Manchester, from whom full particulars can be obtained of this service.

EXPERIENCED IRONMOULDER seeks position as Foreman or Assistant. Accustomed light engineering, jobbing and repetition castings. Good technical training; willing to travel. (397)

FURNACE ATTENDANT, accustomed to metal mixing, cast iron and high-duty cast iron, seeks similar position with engineering foundry West Riding of Yorkshire district preferred. (398)

ASSISTANT FOREMAN with sound and varied experience on light castings, machine tools, etc., desires position as foreman. Exceptionally good technical training, successful engineering student. Experienced in repetition light castings. Highest recommendations. (392)

MACHINERY

WANTED. — 3-Ton Capacity Bottom-Pouring Tropenas Steel Ladle.—F. W. ROWLANDS & CO., Wallasey, Cheshire.

WANTED.—Sand Mill to mill 1 to 1½ tons per hour.—Full particulars and condition to Box 576, Offices of THE FOUNDRY TRADE JOURNAL, 3, Amersham Road, High Wycombe.

MACHINERY—*Continued*

PNEUMATIC MOULDING MACHINES

Macdonald Jolter, table 72 in. by 54 in.

Tabor ditto, table 27 in. by 20 in.

Tabor 21 in. by 16 in. squeeze.

Zimmerman Type R.P.W.2 Jolt Squeeze turnover, table 36 in. by 20 in.

Mumford Type (Jackman) Swing Headpress, 13 in. by 15 in. and 14 in. by 16 in.

Mumford Pneumatic Core Jolters having 15-in. by 20-in. and 12-in. by 12-in. tables.

Britannia No. 1 "Coventry" Pneumatic Turnover Jarr Ram, table 30 in. by 28 in.

50 Air Compressors; 500 Electric Motors, Dynamos, etc.

S. C. BILSBY, A.M.I.C.E., A.M.I.E.E.
CROSSWELLS ROAD, LANGLEY,
Nr. Birmingham.
'Phone: Broadwell 1359.

SAND MIXERS AND AERATORS.—The "Breakir" Centrifugal Machine is *THE* machine. Outputs 10 cwts. to 8 tons per hr.—W. BREALEY & CO. LTD., Station Works, Ecclesfield, Sheffield.

FOR SALE.—One Junior Motive Type Sand-slinger, built by the Foundry Plant & Machinery, Ltd., and only recently put into work. Travelling type with 7-tons sand bin with 12-ft. radius arm. The machine is complete and in first-class condition. Can be seen by appointment.—SIR JAMES FARMER NORTON & CO., LTD., Adelphi Iron Works, Salford 3, Manchester.

NEW Dwarf Cupola, to melt 10 to 15 cwts. per hour; New Worm-geared Ladles, 4-tons, 2-tons, 30-cwts., 20-cwts., 15-cwts. and 10-cwts. capacity; also Osborn Cupola Spark Arresters.—T. DAVIES & SON, West Gorton, Manchester, 12.

THOS. W. WARD, LTD.

14 BABCOCK & WILCOX WATER TUBE BOILERS, heating surfaces 4,410 to 5,540 sq. ft.; pressure 200 lbs. per sq. in., with ECONOMISERS MECHANICAL STOKERS.

CROSS TUBE BOILER, oil-fired, 8 ft. 2 in. by 3 ft. 9 in., w.p. 80 lbs.

LOW PRICES. QUICK DELIVERY.

Write for "Albion" Catalogue.

ALBION WORKS, SHEFFIELD

'Grams: "Forward." 'Phone: 26311 (15 lines).

MISCELLANEOUS

"A STUDY IN ECONOMY"
ACTUAL MANUFACTURES
BY USING OUR

Foundry Blackings, Facings, Parting Powder, Core Gum, Terra Flake, Talc Coal Dusts, Ganister, Ceylon Plumbago (Imports direct). We definitely help to produce perfect Castings. Only the best minerals used in the making. A trial order will convince users of their economic value.

JOHN & C. DURRANS,
PENNINE WORKS, HALLEHEAD,
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